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4. Prof. Girjesh Govil, Ph.D., F.N.A., F.A.Sc., F.T.W.A.S., Mumbai.

CONTENTS

Cover page photograph : Successful air layering in Myrica esculenta: (A) A mature tree growing in the forest (bar = 0.3 m), (B) Rooting of air layered shoots (bar = 4.0 cm), (C) A closer view of root formation (bar = 2.5 cm), and (D) Air layered plants 4 weeks after transfer to earthen pots. (See page 205)

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EDITORS' PAGE

In the Editorial of the last issue (No. 3 & 4) of this journal, a serious concern was raised regarding the lack of Industry-Academia and Industry-Research Laboratory interaction in India, though both stand to gain from the existence of a positive and healthy interaction on this front. Does the same hold good for the Scientists at large and the Government? More or less, yes with the exception of some special agencies like space or atomic energy etc. The New Science Policy Framework, a very promising document, was announced by the Prime Minister in January 2003. It is too early to comment whether this policy framework has succeeded or not in creating a "dent". However, the early signals suggest that much of the promised thrust has been "absorbed", as usual, by the bureaucrats and technocrats. This issue has become more relevant at the present juncture because a new Indian Government would have taken office as this issue of the journal goes to press. It is our earnest hope that the level of appreciation and support for the Indian Science provided by the previous Government (in fact all Governments from Pt. Nehru's days) will not only continue but grow further.

One often wonders, has something seriously gone wrong with all of us as a society in India? We have bureaucrats with no clear-cut administrative goals, both in terms of quality and purpose. The same applies to most politicians with their "hazy ideas" about societal development goals. The Scientist/technocrats have to take their own share of blame when it comes to generating real impact on the emerging scientific frontiers or fulfilling the social aspirations. Each sector (bureaucrats, technocrats and politicians) occasionally are seen raising slogans in favour of "socio-economic revolution through Science and Technology". Are we serious, particularly the political government, in this regard? If yes, then why no newly elected political representatives are talking of or putting claims for the coveted berth of Ministry of Science and Technology (or Human Resource Development) and most of them are running to seek Ministerial berths other than these? Your guess is as good as our!

We appeal to our scientific community to continue to do their best for the national development. Another focussed appeal from us!! Please continue your support to this journal by contributing novel and interesting papers.

Girjesh Govil
Jai Pal Mittal
Suresh Chandra

The views expressed here are solely those of one of the Editors and do not necessarily reflect those of the Academy or the Institute where he works.

Aromatic plants- a source of natural chemo-therapeutants

Anupam Dikshit*, Sushil K. Shahi, K. P. Pandey, Mamta Patra AND Amritesh C. Shukla

Biological Product Laboratory, Department of Botany, University of Allahabad, Allahabad-211002, India
**dranupam_dikshit@rediffmail.com*

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Abstract

According to WHO about 80% inhabitant of the world rely chiefly on traditional medicines for there primary health care and the major part of traditional therapy involves the use of plant extracts or their active principles. In the modern era, however, the use of medicinal plants especially in the developed countries declined with the introduction of synthetic drugs as substitute for natural products. In the developing countries on the other hand, traditional herbal medicines have continued to play an effective role *vis-a-vis* modern medicine, particularly in revival of interest in the use of medicinal plants both in developed and developing countries, because herbal medicines are reported to be safe and do not produce any side effects which are often noticed with the long administration of synthetic drugs. It is perhaps for this reason that today; over 25% of the prescriptions issued in the developed countries are reported to contain one or more plant drugs. A number of International organisations as UNIDO, UNESCO, WHO and Commonwealth Science Council have volunteered to support research programmes in this area. Thus, in the meaningful search of new drugs with better and cheaper substitutes, plant resources are natural choice. Present report on the possibility of the use of higher plants and their constituents have indicated their fruitfulness in providing antifungal agents (antidermatophytic agents) which are largely non-toxic to human beings, more systemic and easily bio-degradable.

(Keywords : essential oils/ aromatherapy/ volatile substances/ medicinal plants)

Green plants, because of their vast diversities, contain a variety of plant chemicals as metabolites, most of which makes a vital contribution to the list of medicines for human health.[1] Various ancient manuscripts such as the Bible, the Rig-Vedas, the Iliad and the Odyssey and the history of Herodotus reported the use of plants for curing human ailments. Over 6000 years ago, the ancient Chinese were using drug plants. The Egyptians, Babylonians, Sumerians, Greeks and Romans, all developed their receptive characteristic Materia Medica. On the other side of the world, the Aztecs, Mayans and Incas had all developed primitive medicines. Some of the ancient Egyptian text books 'Papyri' (such as the Edwin Smith Papyrus and the Ebers Papyrus), written as early as 1600 BC, indicates that

the Egyptians had an amazingly complex Materia Medica. In India, the Ayurvedic system of medicine has been in use for over three thousand years. Charaka and Susruta, two of the earliest Indian authors had sufficient knowledge of the properties of the Indian medicinal plants. Their medical works, the Charaka Samhita and the Susruta Samhita are esteemed even today as treasures of literature on indigenous' medicine.

The antimicrobial activity of aromatic substances has been known for more than seventy years. Macht and Kunkel[2] and Dyche-Teague[3] described the antimicrobial effect of volatile oils or their vapours. Later, Maruzzella and Lignori[4], 1958; Maruzzella *et al*[5], reported rather extensive surveys of the antimicrobial action of many essential oils and perfumery chemicals in both the vapour phase and by direct contact of the liquids. However, despite this vast knowledge of use of phytochemicals from the higher plants, these unending resources have largely remained untapped so far.

Herbal remedies have been used for centuries but more recently the compounds that are active have been identified and this has enabled them to be extracted and purified, synthetic organic chemists have been able to produce the molecules in vitro and so produce them on larger scales. Plant metabolites are used as drug, food, flavours, colour, dyes, poisons, perfumes, and scented oil in the aromatherapy and industrial products. It is estimated that ¼ of prescription. drugs contain at least one chemical originally identified and extracted from a plant. Plant pigments, alkaloids, isoprenoids, terpenes and waxes are some examples of secondary products. Secondary plant products have for thousands of year played an essential role in medicine. Traditionally, they have been directly used as foods and herbs. Now a day, they are used either directly or after chemical modification. Plant secondary metabolites represent tremendous resources for scientific and clinical researches and new drug development. Over all, their pharmacological value not only remains undiminished until today, but also is increasing due to constant discovery of their potential role in health care and as lead chemical for new drug development. The products of plant secondary metabolisms, despite their enormous diversity are grouped into following categories *viz.*, alkaloids, glycosides, isoprenoides, terpenes, plant amines, phenolic compound, polyisoperene, rubber like polymers and rare amino acid. The essential oils are grouped under isoprenoid and terpenes category.

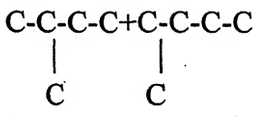
Natural chemotherapeutants

Chemistry, location and functions : Natural chemotherapeutants (essential oils) are also known as ethereal oils and defined, as the oils obtained by steam distillation of plants[6]. Some what more detailed is the definition of Parry[7] who states that for all practical purposes, the essential oils may be defined as odoriferous bodies of an oily nature, obtained almost exclusively from vegetable sources, generally liquid at ordinary temperature and volatile without decomposition. This definition makes a distinction between the fatty oils and oils which are easily volatile. The volatility and plant origin are the characteristic properties of these oils. They are not lipids in the chemical sense but have many of the physical properties of the oils. They are oily in character and form temporary greasy spot on paper. They are actually a group of

heterogeneous volatile fragrant compounds found especially in plants. The term essential oil is misleading as it suggests that these compounds are very important to the plants in which they occurs. Actually the name is derived from the fact that they are the substances found in essences or volatile compounds, which give many plants their characteristic odour.

a. Chemistry

Chemically the essential oils are composed of organic compounds, usually hydrocarbon, alcohol, aldehyde and ketone in nature. It is with the advancement of science that a better knowledge of the constituents of the oils is gained. It is found that the oils contain chiefly liquid and more or less volatile compounds of many classes of organic substances. Some of these are aromatic compounds; still others are aliphatic substances, which belong largely to the ester or aldehyde classes. In general, however, most of the compounds belong to the general class of substances known as terpenes. The name terpene is derived from the English word "Turpentine"[9]. The terpenes are generally colourless liquids, which are lighter than water and boil in the range of 140-190°C temperatures. They are insoluble in water, highly refractive and optically active and rotate the plane of polarised light. The terpenes are the unsaturated hydrocarbons, which have a distinct architectural and chemical relation to the simple isoprene molecule C_5H_8. They have the molecular formula $C_{10}H_{16}$, thus are constituted by two isoprene units combined by head to tail union[10].



The terpenes may be open chain or cyclic substances containing two isoprene units. Related to these are sesquiterpenes (three isoprene units), diterpenes (four isoprene units), tri and polyterpenes. Terpene derivatives are made up of isoprene units to which have been added the elements of water (H and OH) or simply an oxygen atom[11] to give $C_{10}H_{18}O$ and $C_{10}H_{16}O$. The functional groups are more frequently alcohols, aldehydes, ketones and esters.

It is evident that terpene molecules contain six hydrogen atoms fewer than the molecule of the corresponding saturated hydrocarbon $C_{10}H_{22}$. Since every double bond or ring closure reduces the amount of hydrogen by two atoms, the terpenes may be divided into four groups[12].

1. Acyclic terpenes
2. Monocyclic terpenes
3. Bicyclic terpenes
4. Tricyclic terpenes

b. Location in the plants

The essential oils have been found to be not uniformly distributed throughout the plant. According to Strauss[13], the volatile oils secreted as a result of various metabolic processes in plants accumulated in the specific cells or vessels of a variety of organs; leaves, flowers, fruits, stem or roots of the plant in a manner characteristic of the family of the individual plant. The essential oils secreted as a result of known metabolic process had been observed to be accumulated in the form of oily droplets in some cells or spaces in the plant tissues. The oil had been found in different cell groups distinguished as internal and

external gland cells. The external glands were epidermal cells or modification of these such as excretion hairs. These glands contained oil usually accumulated outside the cell between cuticle and the rest of the cell wall. The cuticle being thin skin was liable to break with a slight touch. Thus, on touching the plant the observer immediately feels its well-known flavour. The internal glands were located throughout the plant; they were formed by the deposition of the oil between the walls of the cells. The intercellular glands often had grown to form long canals, coated on the inside with a layer of thin walled cells. This coating was stated to have a double function, the separation of the other tissues from the oil and formation of the oil. The oil formed in the epithelial cells or in the membranes passed through the cell wall into the interior of the gland. These oil glands were unequally distributed throughout the plant. According to Welch[14], their existed relationship between the oil glands and oil yield. No doubt, the theoretical values for certain species with small yield agreed fairly well with the actual yields, but in the majority of species there was such a wide variation that it was impossible from such determinations to predict accurately the approximate yield of the oil.

c. Functions in the plants

The function of essential oils in plants is not thoroughly understood. They were considered as the waste products of the plants in the past. The observations based on recent research revealed that they have specific functions in the plants.

The essential oils being volatile compounds give many plants their characteristic odour and smell, which is constantly diffused from the plant into the air, thus dispersing the odour, characteristic to the plant in the surrounding atmosphere. The insects are reported to be very sensitive to the essences. It was observed that oil-bearing plants were attractive to certain insects while others were repellent. Some useful insects were probably attracted to visit the flowers, thus contributing towards more effective cross-pollination, influencing ultimately, the bearing quality of the plants.

The essential oils, due to their penetrating and irritating odours were observed to act as repellents for certain insects and animals. The presence of essential oil in roots, woods, leaves, flowers and fruits might act as protection in a number of plants against the plant parasites and against the depredation of animals[15]. The basic cause of formation of essential oil seemed to protect the plants from environmental germs. Although plants are reported to produce many type of defence chemicals but maximum antibiotic activity was associated with the essential oils which possessed all the qualities of man made chemical warfare agents: vaporising and spreading into a vast area, penetrating, paralysing and destructive to harmful agents like insects, bacteria, fungus, germs and animals.

Some observers maintained that the essential oils functioned as reserve food, as a means of sealing wounds or as a varnish to prevent excessive evaporation of water but these opinions did not appear to be supported by experiments. It was also reported that the plants that contained a considerable amount of essential oils were prevented from becoming too warm, since heat was absorbed in the vaporisation of the oils. But results from experiments showed that effect was negligible

Table 1– List of aromatic plants having various medicinal properties.

S.N.	Plant	Local name	Family	Distribution of Plant	Yield of oil	Chemistry of oil	Medicinal use of the oil
1	*Anethum graveolens* Linn.	Dill seed (soya)	Apiaceae	In India it is cultivated in Jammu and Kashmir	Seeds contain 2.1-3.5 % oil[16]	α-pinene 0.8%, myrcene 0.7%, α-phellandrene 29.0%, carvone 35.2%, limonene 25.0%,[17] dihydrocarvone 14.3%[18]	Oil used as aromatic stimulant, in digestive troubles, flatulence, dyspepsia and diarrhoea
2	*Apium graveolens* L.	Karnauli or Ajmod	Apiaceae	France, India, Holland, China, USA are the main cultivers. In India Amritsar, Ladwa, Sharanpur, Kamal are the important cultivers[19]	Seeds contain 1.75-2.45% oil[20]	Limonene 80%, n-pentyl benzene 1.0%, caryophyllene 0.5%, α-selinene 0.5%, sedanolide 0.5%[21]	Used as nerve stimulant, antispasmodic and sedative.
3	*Artemisia vestita* Wall. ex DC.	Davana	Asteraceae	Plant grows wild in the temperate Himalayas from 2100-3000 M above sea level. It is common in the Kashmir valley[22], Simla Hills and Naini Hills[23]	Air -dried leaves and flowering tops yield 0.8% of pale yellow oil.	α-terpinene 21 %, thujyl alcohol 10.1%, terpinyl acetate 9.8%, nerol 8.8%, 1,4-cineole 8.6%, thujyl acetate 5.8%, artemisol 4.4%[24], α-pinene 0.56%, 1,8-cineole 5.3%, camphor 1.13%, artemisyl acetate 3.00%, α-himachalol 5.0%[25]	The oil posses antibacterial and antifungal activity in 1 : 1000 dilution.[26]

Table 1 Contd...

				is cultivated in the hills of Kashmir, Kumaon and Garwhal. It is also cultivated in Northern and central Europe.	8.1 % yield of essential oil[27]	sabinene 0.1 %, myrcene 0.6%, limonene 49.8%, α-terpinene 0.1 %, carvone 47.1%[28]	carminative. It is also used in mouth wash, tooth paste and as a masking agent in bad tasting. It has been recommended for dyspepsia, hysteria and indigestion[29]
5	*Cedrus deodara* (Roxb.) Loud.	Deodar	Pinaceae	Plant grows an altitude of 1200-3000 m in an area where rainfall varies from 100-175 cm. Plant commonly grows in the forests of Jammu and Kashmir, Himanchal Pradesh and Uttar Pradesh[30]	Saw dust contains 2.0-4.5% oil[31]	α-pinene 0.08%, limonene 1.20%, β-cedrene 1.40%, α-cedrene 15.82%, β-himachalene 12.34%, α- himachalene 30.83%, deodarone 5.38%, cedrol 1.36%[32]	Oil possesses diaphoretic, diuretic and carminative properties, it is useful in diarrohea, dysentery, ulcers and skin diseases[33]
6	*Cinnamomum camphora* (Linn.) Nees and Eberm.	Camphor	Lauraceae	Camphor tree grow well at 1,350-to 1800 mt. height. Camphor plant is found in Nilgiris hill, Jorhat, Dehradun and State of Karnataka	Wood and roots contains 1-1.2% yield of oil	The oil contains normally 50% camphor[34], linalool 80%, 1,8-cineole 76%, limonene 10%[35], sabinene 1.47%, eugenol 0.12%, safrole 13.4%, piperitone 2.41 %[36]	The oil has germicidal and fungicidal properties. Oil is prescribed in gastrodynia, flatulent colic and gastric debility.[37]

Table 1 Contd...

7	*Cinnamomum tamala* Nees & Eberm.	Tejpat	Lauraceae	Grows at an altitudes of 1000 - 2700m. Kashmir, Sub - tropical Himalayas, Khasia, and Jainta hills, Bengal are the important cultivers[38]	Leaves contain 0.23 -0.36% oil	Cinnamaldehyde 41-55.19%, linalool 15.0 - 15.67%, borneol 1.07 - 1.08%, caryophyllene 4 - 7.26%, α-terpineol 1.54 -1.77%, benzyl cinnamate 1.81 - 1.87%, benzaldehyde 2 - 4.11%[39]	Leaves and barks are carminative and used in many ayurvedic preparations.
8	*Cinnamomum verum* Presl (syn. C. *zeylanicum* Breyn.)	Cinnamon	Lauraceae	Native of Ceylon, Srilanka. In India, it grows in Nilgiris, Western ghats in Cannanore, Calicut and Kottayam districts of Kerala[40]	Green leaves contain 0.75 % oil while bark contains 0.5-1 % oil	α-pinene 0.2%, 1,8-cineole 1.65%, p-cymene 0.35%, linalool 1.5%, caryophyllene 1.85%, α-terpineole 0.15%, eugenol 87%[41]	Powder cinnamon is a reputed remedy for diarrhoea and dysentery.
9	*Corandrum sativum* Linn.	Coriander (dhaniya)	Apiaceae	In India it is cultivated in Andhra Pradesh, Bihar, Karnataka, Tamilnadu, M.P., U.P. and Rajasthan	Fruit contains 0.1-1.8% oil	α-pinene 0.96-7.97%, β- pinene 0.6-1.7%, α-terpinene 1.06-2.20%, linalool 59.55-71.61%[42]	Seeds are stimulant, aromatic, stomachic, carminative, leaves are diuretic, purgative.
10	*Cuminum cyminum* Linn.	Cumin	Apiaceae	In India it is cultivated in Rajasthan, M.P. and Gujarat	Seeds contain 2.5-4.5% oil	Myrcene 0.12%, sabinene 3.38%, β-terpinene 0.68%, α-terpinene 0.09%, β-phellandrene 0.93%[43] β- pinene 19.7%, cuminaldehyde 22.4%[44]	Stomachic, stimulant, carminative, astringent and used in diarrhoea.

Table 1 Contd...

11.	*Curcuma longa* L.	Turmeric	Zingiber-aceae	It is cultivated in Tamilnadu, Maharastra and Bengal.	Rhizome and leaves contain 2.2 % essential Oil[45]	ar-turmerol 16.7-25.7 %, a-termerone 32 %, b- termeron 18.4%, 1,8-cineole 14.6%[46]	Leaf oil possesses strong antimicrobial properties[47]
12	*Cymbopogon citratus* (DC) Stapf	West Indian lemongrass	Poaceae	West Indies, Guatemala, Brazil and India are the important cultivars. In India, it is cultivated in Northern district of Travancore and Cochin as well as in Sagar district of M.P.	Fresh leaves contains 0.2-0.4% oil	Citral-a 41.82%, citral-b 30.32%, geraniol 1.85%, elemol 1.20%, myrene 12.75%, citronellal 0.73%[48]	Aromatic stimulant and carminative, possesses antimicrobial activity and antifungal activity. Oil use as a remedy for indigestion, reliving colic pains. It is also used in the preparation of ointment and lotions
13	*Cymbopogon flexuosus* (Steud.) Wats	East Indian lemon grass	Poaceae	In India, it is found in northern district of Travancore and Cochin at altitude of 150 m as well as in Sagar district of M.P. Commercially cultivated in Assam, Maharashtra and Uttar Pradesh	Fresh leaves contains 0.2% to 0.4% oil	Geranial 51.19%, citronellal 0.37%, α-terpineol 0.38%, α-pinene 0.24%, myrcene 0.46%, limonene 2.42% and methyl heptenone 1.43%[49] are the important constituents.	Oil is aromatic stimulant and carminative posses antimicrobial activity and antifungal activity. Oil used as a remedy for indigestion, reliving colic pains. It is also used in the preparation of ointment and lotions

Table 1 Contd...

14	*Cymbopogon martini* (Roxb.) Wats	Palmarosa	Poaceae	Commonly cultivated in M.P., Maharastra, Andhra Pradesh, Karnataka	Whole plant 0.1-0.4%, leaves 0.16-0.25%, flowering tops 0.45-0.52%	Geraniol 36.3-64.7, linalool 2.4%, citronellol 6.4%, geranyl acetate 5.7%[50]	Used as a antifungal agent and in medicinal soaps
15	*Cymbopogon pendulus* (Nees ex. Steud) Wats	Jammu lemongrass	Poaceae	In India, Bengal, Sikkim, Assam, M.P., J&K and hilly areas of Kangra (Palampur)	Fresh leaves contains 0.2-0.4% oil	Citral-a 43.29%, citral-b 32.27%, geraniol 2.60%, elemol 2.29%, geranyl acetate 3.58%[48,51]	Used as an aromatic stimulant and carminative posses antimicrobial and antifungal activity. Oil used as a remedy for indigestion, reliving colic pains.
16	*Cymbopogon winterianus* Jowitt	Citronella	Poaceae	Commonly cultivated in Mizoram, Meghalya, Nagaland, Tripura, Arunachal Pradesh, M.P., Maharastra, Andhra Pradesh, Karnataka	Leaves contains 1.0-1.2% oil	Geraniol 12-18%, limonene 2-5%, citronellol 11-15%, citronellal 32-45% elemol 2-5%[52]	Used as an antifungal agent and in medicinal soaps
17	*Cyperus scariosus* R.Br.	Cyperus (Nagar Motha)	Cyperaceae	In India U.P., M.P., Bengal, Punjab are the important cultivers.	Rhizome contains 0.2-4% oil.	Cyperenone, isopatchoulene[53]	Used in indigenous system of medicine and in hair oil.

Table 1 Contd...

18	*Elettaria cardamomum* Maton	Cardamom	Zingiberaceae	Plants grows in Shimoga, Hasan and Kadur districts in Karnataka and Kodaikanal hills in Tamilnadu at a temperature range of 10-35°C	Whole cardamom contains 3.5-7% of oil	α-pinene 1.40%, sabinene 3.10%, 1,8 cineole 44%, α-terpinyl acetate 37%, linalool 3.00%, α-terpinene 1.10%, α-terpineol 1.50%[54], terpinolene 0.5%, methyl eugenol 0.2%[55]	Oil used as an aromatic stimulant and carminative agent
19	*Eucalyptus citriodora* Hook	Eucalyptus	Myrtaceae	Commercially cultivated in Malabar, Nilgiris, Ranikhet, Kulu and Kangra	Green leaves contain 0.5-4.8% oil	α-pinene 0.1-1.9%, 1,8 cineole 17.9%, citronellal 82.6%, citronellol 13.4%[56]	Antiseptic, antifungal, stimulant, expectorant in chronic bronchitis
20	*Eucalyptus globulus* Labill.	Eucalyptus	Myrtaceae	Native of Australia, In India, cultivated in Nilgiri Hills, Shimla hills, Shillong hills etc.	0.6 -0.8% oil in fresh leaves	Camphene, α-terpinene, citral, sabinene, myrcene, cineole, borneol, myrtenol, eudesmol, thymol, aromadendrene[57]	Oil used in treatment of asthma and bronchitis, antifungal activities are also reported.
21	*Foeniculum vulgare* Miller	Fennel (saunf)	Apiaceae	Native of the Mediterranean region. Cultivated in France, Italy, India, Bulgaria, Spain, Morocco. In India, Punjab, Assam, Baroda, Maharastra are the important cultivers	Fruit contains 0.7-2.0% oil	α-pinene 3.7%, fenchone 12.9%, trans-anethole 70.0%, β-pinene 0.5%, limonene 3.5%[58]	Fruits are used medicinally as carminative and stimulant[59]

Table 1 Contd...

22	*Jasminum grandiflorum* Linn.	Yasmin (Juhi)	Oleaceae	In India, Bengal, Orissa, Assam, Maharastra, Tamilnadu, U.P., Punjab, Kashmir and Western Himalayas are the important cultivars.	Seeds contain 0.28-0.34% oil[60-61]	Benzyl acetate 65%, Linalool 15%, indole 2.5%, cis-jasmone 3%, methyl anthranilate 1.5%, geraniol 10%, α-terpineol 5%, eugenol[62] etc.	Commonly used for the preparation of hair oil
23	*Juniperus communis* Linn.	Junipers	Cupressaceae	Commonly grows in the Western Himalayas, Kumaoon and the Kurram valleys at an altitude of 3500-4000m	Ripe fruits contains 0.8-1.6% oil	α-pinene 33.7%, sabinene 27.6%, 1,4-cineole 4.0%[63], Terpinolene 1.6%, limonene+β-phellandrene 6.9%, α-selinene 1.05%, α-muurolene 2.7%, citronellal 1.6%, β-elemene 0.50%[64]	Stimulant[65-66], diuratic, stomachic, carminative in digestion, flatulence and in diseases of kidney and bladder.
24	*Lavendula angustifolia* Mill	Lavandin	Lamiaceae	Spain, France, Switzerland, North Italy and N. Africa are the important cultivars.	Flowering tops contain 0.5%-1.5%[67] oil	Linalyl acetate 32.2-44.8%, terpinene-4-ol and caryophyllene 3.8-11.8%, lavandulyl acetate 1.3-4.1%, lavandulol 1.3%, borneol 0.8-1.4%, α-pinene 0.6%, limonene 0.7%[68]	Used for the tumours of the breast, liver, sinews and spleen and other types of cancers[69]. Also used as diuretic, sedative, stimulant, carminative and stomachic and tonic[70-71]
25	*Mentha arvensis* L.	Mint (Pudina)	Lamiaceae	Commonly cultivated in Brazil, Paraguay, China,	Fresh leaves contain 0.4-0.6% oil	Menthol 78.24-82.78%, Easter menthol 4.74-5.01%,	Used as carminative, stimulant, in

Table 1 Contd...

				Argentina, Japan, Thailand, Angola, India. In India, Western Himalayas, Kashmir, Punjab, Kumaoon and Garhwal.		Acetyl menthol 6.01-6.36%, menthone 11.85-13.75%[72], linalool 0.8%, neo-menthol 1.6-2.2%, piperitone 1.8-2.7%, ,β -pinene 1.3%[73]	nausea, sickness, vomiting and also for toothpastes, dental creams, mouth washes.
26	*Ocimum basilicum* Linn.	Sweet basil (Tulsi)	Lamiaceae	Sweet or French basil is cultivated all over India, France, Italy, Bulgaria, Egypt, Hungary, 'South Africa and occasionally in the United States.	Whole herb yields 0.1-0.25% oil and young inflorescence contains about 0.4% oil.	α-pinene 0.11 %, camphene 0.07%, β-pinene 0.21 %, myrcene 0.16%, limonene 0.12%, 1,8-cineole+cis-ocimene 2.70%, menthol 0.27%, α-terpineol 0.90%, citronellol 2.80%, eugenol 6.60%[74]	Oil is used as mouth wash and dental cream, it is also recognized as febrifuge and antimalarial plants[75], it is used for cephalagia, gouty joints and as a gargle for foul breath, ear ache.
27	*Pogostemon cablin* Benth.	Patchouli	Lamiaceae	Malaysia, Indonasia, Singapore and India. In India commonly cultivated in Bangalore and coastal areas of South India.[76]	Leaves contain 2.5-3.5% oil	β-patchoulene 1.9-2.2%, α-guaiene and caryophyllene 11.3-22.2% α-patchoulene and aromadendrene 10.8-20.9%, α-bulnesene 2.3-13%, patchouli alcohol 23.6-45.9%[77]	Medicinally used in drugs to treat nausea, diarrhoea, cold and headache.
28	*Rosa damascena* Mill.	Rosa	Rosaceae	Temperate plant, indigenous to Europe & Middle East countries, Iran,	Flower contain 0.03% oil.[78]	Citronellol 38%, paraffins 16%, geraniol 14%, nerol 7%, linallol 2%,	Rose oil at the rate of three drops, three times daily may

Table 1 Contd...

				Afghanistah, Turkey and India. In India U.P .and Rajasthan are main growing areas		ethanol 2%, famesoll%[79] are important constituents.	be used for the treatment of gallstones.
29	*Rosmarinus officinalis* L.	Rosemary	Lamiaceae	Spain, Portugal, Morocco, Algeria and India. In India, it is cultivated in temperate Himalayas & Nilgiri hills[80]	Whole plant gives 1.0-1.5% oil	Fenchone 2.5%, α-terpineol 3.7%, safrole 0.8%, 3-octanone 0.4%, α-thujone 1.1 %[81] α-pinene 27%, verbinone 29%[82]	Antimicrobial, medicinal shampoo and soaps
30	*Santalum album* L.	Sandal	Santalaceae	It grows commonly at altitudes of 600-1 050m above sea level. Annual rainfall from 60-160cm. is ideal for growth. Karnataka and Tamilnadu are the important cultivers.	Root 10%, Chip 1.5-2%	Santalyl acetate 20%, α-santalol 60%, β-santalol 30%, santene, santenol, santenone and borneol are the Important constituents[83]	Medicinally for healing wounds, for blisters caused by small pox vaccination oil proves the best treatment.
31	*Skimmia laureola* Sieb.& Zucc Ex. Walp.	Skimmia	Rutaceae	In India, Jammu and Kashmir Chamba, Kulu (H.P.), Garhwal and Kumaon	Freash leaves 0.5-0.8%, Stem 0.1 %[84]	Linalool 17.5%, linalyl acetate 71.5%, α-pinene 0.33%, myrcene 0.4%, citral 0.1 %, nerol 0.27%, β-phyllendrene 1.2%[85]	Used in protection against small pox and others.
32	*Syzygium aromaticum* (Linn.) Merill and Perry	Clove	Myrtaceae	Nilgiris, Tirunelveli and Kanyakumari district of Tamilnadu and Kottayam and Ernakulum district of Kerala are	Oil yield in clove buds 17 -18%, clove stems 6% and clove leaves	Eugenol 85-90%, caryophylene 4-8%, α-humulene 0.55, methyl eugenol 0.1 %, chavicol 0.3%,[86]	Anti-carminative, antispasmodic and antibacterial[87]

				important cultivars.	2-3%		
33	*Thymu vulgaris* L.	Thyme	Lamiaceae	Germany, France, England, India, Western temperate Himalayas from Kashmir to Kumaon between altitudes of 1500 - 4000m.[88]	Flowering tops contain 2% oil	*p* -cymene 15 - 50%,. linalool 3 - 13%, linalyl acetate 0- 6%, borneol 2 -8%, carvacrol 0 - 20%, thymol 5 - 60%[89] are the important constituents.	Antiseptic, antibacterial, disinfectant, used in vermifuges and anti-gastrointestinal products, in whooping cough[90]
34	*Trachyspermum ammi* (L.) Sprague	Ajowan	Apiaceae	Plant is native of Egypt. It is cultivated around the Mediterranean sea and in Southwest Asia. In India it is grown in Maharashtra, Gujrat and West Bengal[91]. It is also found growing wild in certain parts of India	Crushed fruits yield 2-4% essential oil which is colour less or brownish yellow[92]	The oil contains carvacrol 4.50-6.80%, thymol 45.20-48.50%, *p*-cymene 23.78% limonene 0.2-2.25%[93] α-pinene 1.8%, β-pinene 3.5%, γ-terpinine 34.9%[94].	Oil is aromatic, stimulant and carminative, possesses antimicorbial[95] and antifungal activities, oil used as a remedy for indigestion, relieving colic pain. It is also used in preparation of ointment and lotion.[95,96].
35.	*Vetiveria zizaniodes* (Linn.) Nash also known as *Andropogan muricatus* Retz.	Vetiver	Poaceae	In India Rajasthan (Bharatpur, Moosanagar, Kuriyalaghat), Uttar Pradesh[97], Tamilnadu, Kerala and Andhrapradesh[98] are the important cultivars.	Root contains 0.3% oil.	Khusimol 20%, vetiselinenol 19.5%, elemol 0.8%, β-eudesmol 6.5%, β-vetivone 4.1 %, α-vetivone 5.2%[99]	Root is used for refreshing in fevers, inflammations and irritation of stomach.

Table 1 Contd...

36	*Zingiber officinale* Rose.	Ginger (adrak)	Zingiberaceae	Native of South East Asia. India, Australia, Japan and China are the top cultivars. In India Kerala, U.P., West Bengal, Maharastra, Sirmurdistrict in H.P. and Andhra Pradesh are Important growing areas	Rhizome contains 1.0-2.7% oil	α-pinene 0.4%, β-pinene 0.2%, camphene 1.1 %, myrcene 0.1 %, limonene 1.2%, 1,8 cineole 1.3%, linalool 1.3%, d-bomeol 2.2%, α-celinene 1.4%, β-elemene 1.0%, β-zingiberene 35.6%, arcurcumene 17.7%, β-farnesene 9.8%[100-102].	Antimicrobial, carminative and digestive stimulants.

Table 2– Location of aromatherapy centres.

NAME OF CENTRE	LOCATION
Indus valley Ayurveda centre (IVAC)	(IVAC), Chamundi hills, Mysore, 570010 Karnataka, India.
Udaivilas	Udaipur, Haridasji Ki Margi, Udaipur, Rajasthan, India.
Rajvilas	Spa Hotel, Jaipur, Rajasthan, India.
SBYM centre	Kovalum, Kerela, India.
ANH centre	Hotel Bougainvella, North, Goa, India.
KEVELA centre	54/1757(1), Chemmannuila, Viswanbaran Road, Pappanocode, Trivandrum, Kerela, India.
Spa Agnand centres	Goa, India
Ananda, centre	The palace estate, Narendra nagar, Tehri Garwal , Uttaranchal India.
KEVELA, centre	Mumbai, India.
Amarvilas, centre	Agra, UP, India.
Wild flower Hall, centre	Shimla, HP, India

Conclusions

In this age when mankind is threatened by drastic global environmental changes triggered by our activities, we need to investigate and develop alternative strategies for concluding our affairs, the use of sustainable and environmentally appropriate practices in human life can greatly contribute to the ecological stability of the planet. The essential oil are used in various ways, viz., in medicine, naturopathy, cosmetics etc. In recent years special centres are run through based on amazing power of refreshment in the way of essential oil therapy or aromatherapy. Aromatherapy, in which different types of essential oils are used as body healer. Aromatherapy, is now recognized as a natural heading art for rejuvenating human body externally as well as internally. Centres (Table-2) such as, Indus valley Ayurveda centre (IVAC), Chamundi hills (Mysore) Karnataka, Udaivilas in Udaipur and Rajvilas in Jaipur both in Rajesthan, ANH centre in Goa, SBYM centre in (Kovalum) Kerela, KEVELA centre both in Kerala and Bombay, PVY and Spa Agnand centres in Goa, Amarvilas (Agra) UP, Wild flower Hall, (Shimla, HP) and Ananda in the Himalaya, Tehri Garwal, Uttaranchal are some excellent centre for aromatherapy. In these centres various essential oils are used for different cosmetic treatments and body allignements. The results of aromatherapy is amazing thus the

demand increases day by day directly and indirectly enhance the consumption of essential oil. The essential oil also have cosmetic values such as, astringent (Geranium, lemon), skin toner & patch remover (Lavender), burn (Lavender, Eucalyptus), scars (Lavender), antioxidant (Curcuma), moisturizer (Sandal wood), message (Sandal wood, Lavender, lemon, Cumin, Rose, Vetiver), chapped skin (lemon, Sandal, Tea tree oil), Sagging skin (Lemon grass oil), Stretch marks, (lemon grass), sun burn (lemon), Wrinkle (sandal wood), cleanser (Lemon oil) etc, thus different cosmetic product farms are growing rapidly. Different cosmetic products based on natural ingredients are now become the first choice. These qualities increases the importance of essential oils in our standard life thus the review will be highly beneficial for workers engaged in the field. The application of volatile substances of green plants as biological-drugs on human diseases reducing and replacing synthetic drugs can play a significant role in maintaining or improving the state of the global environments and other use of green plants may also be very beneficial to man. Further collaborative efforts in research are required to make the best utilisation of these important natural resource as "natural chemotherapeutants".

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Alternative medicines in Parkinson's disease

S.P. Bhatnagar

Brentwood Apartment, 35 Defence Colony,Bangalore, India.

Email: surendra@blr.vsnl.net.in

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I have been asked to write a general article on the above subject and I accepted it because of variety of reasons. First of all being a patient of Parkinson Disease myself I try not to write about it because of my abhorrence for it. Life is wonderful, and there are very few things that I despise with a vengeance and count them on half fingers and Parkinson Disease is one of them. Ironically, in 1968, as a postdoctoral student in organic chemistry, I was working on the microbiological transformation of L-tyrosine to levodopa, never did I dream that one-day I would require this drug myself.

The second and most important reason is that I am the President of Parkinson's Disease Society of Karnataka and meet large number of patients. Recently, Dr. Uday Muthane, a Neurologist at the National Institute of Mental Health & Neurosciences at Bangalore, who looks after me, and myself were invited by Lancet Neurology to write an article on our "Experiences in Parkinson's Disease in India".

It is very difficult to write what is good for this disease and what is not because it continuous to be a puzzle, although thanks to Michael J. Fox and other organizations that active research has been initiated. The day Michael J. Fox simply could not get out of the limousine he realized that he was in a serous trouble. He kept this secret with him for 7 years and it was when he publicly announced that he had this disease, it got the attention of the world community.

It was the moving speech of testimony of Michael J. Fox and Muhammad Ali, before U.S. Congress, that helped the cause of fighting this dreaded disease. Huge grants were given to the National Institutes of Health, Bethesda, U.S.A for research in this disease.

This disease is so merciless that it does not distinguish between old and young, rich and poor, educated or uneducated. The dangerous consequences of this disease can only be explained by quoting few words from the Michael J. Fox's book wherein he mentions "My brain was serving notice: it had initiated a divorce from my mind. Efforts to contest or reconcile would be futile; eighty percent of the process, I would later learn, was already complete. No grounds were given, and the petition was irrevocable. Further, my brain was demanding, and incrementally seizing, custody of my body, beginning with the baby: the outermost finger of my left hand."

Perhaps it would be useful for people unfamiliar with this disease to quote Mrs. Muhammad Ali "to the world my husband is known to be an Olympic Gold Medalist, the Heavyweight Champion of the World and a man who has always stood up for what he believes in. No matter, what the cause, Muhammad has used his charm, grace and wit to better the world. Today however, he is facing an opponent unlike any he has ever fought." Just as the million other Americans who suffer from Parkinson's, Muhammad is battling a relentless, remorseless, insidious thief. Parkinson's recognizes no titles, respects no achievements, nor bows to any amount of talent, courage of character.

PD is commonly considered as a disease of only the elderly but this is not true as about 10% develop the disease below the age of 50 years. It affects men and women in almost equal numbers and knows no social, economic or geographic boundaries. PD has no known cause and no cure. Parkinson's disease is a slowly progressive neurodegenerative disorder, that occurs when certain nerve cells (neurons) in the midbrain area called the substantia nigra die or become impaired. Normally, these neurons produce a vital substance known as dopamine. Dopamine is the chemical messenger responsible for transmitting signals between the substantia nigra (Latin term, "black substance") and the next "relay station" of the brain, the corpus striatum, allowing smooth, co-ordinated function of the body's muscles and movements.

Former Stuntman Tim Lawrence was diagnosed with Parkinson's when he was 34 years of age. Two years ago he featured on TV's Horizon in a story on the possible effects of Ecstasy (MDMA) on Parkinson's wherein he reflects on the adjustments he's made as a younger person with PD and how he considers the future. "I can trace this particular terrorist in my body back to a single incident in 1993. I was getting on a bus, holding my dog by his lead in my right hand, and about to pay the driver with my left. A simple act suddenly made near impossible by my thumb's refusal to co-operate. At the time I was more concerned with holding up other people than questioning it, so I merely switched roles between hands and proceeded with the journey. For the next two years a gradual creeping inertia made itself apparent – though only on my left side –I was starting to experience mobility in circles, with my left leg joining the internal protest. I remember saying to friends that if I had a name for what was happening to me, then I'd know what, and how, to fight. In August 1995, I got the name, but Parkinson's disease was not the name I wanted to hear. How could I fight this?"

In this essay, I propose to debate if alternative medicines have a role in treating PD. I have discussed this matter with Dr. Uday Muthane, who has written an interesting article on Ayurvedic medicine, "Did ancient Indians know of Parkinson's Disease (PD)? There has been a considerable debate on this issue. The disease is eponymous to James Parkinson's following his excellent clinical description in 1817. However, one wonders if this disease was unknown prior to the 19th century. Charakasamahitha, the authoritative Ayurvedic text that was written possibly in 5000-3000 BC, makes a mention of this condition as 'Kamapavata', the literal translation of which means tremors secondary to a neurological disease. A modern day neurologist may not completely agree this to be an accurate

description of PD. But amazingly the Ayurvedic Materia Medica by Atmagupta recommends use of Mucuna pruriens and Hyoscyamus reticulatus that contain levodopa and hyoscyamine, an anticholinergic, for the treatment of 'Kampavata'. This suggests that although the clinical descriptions of PD in the Ayurvedic texts, as is known today, may not have been very accurate they did use the appropriate drugs for its treatment. It appears that Ayurveda does not discriminate between the various causes of tremors namely PD and essential tremors."

Effect of Ayurvedic Drugs :

The plant *Mucuna Pruriens* is a twiner belonging to the Leguminosae family. It has turgid S-shaped pods covered with hairs that cause intense itching on contact with the skin. The seeds of *Mucuna Pruriens* were known to contain levodopa much before levodopa was ever used in the treatment of PD. Levodopa was introduced in the treatment of PD after the understanding that PD is caused by reduction in brain dopamine levels and its symptoms improve following administration of levodopa. Powdered seeds administered alone to 23 PD patients for three weeks results in significant improvement of PD. These patients report improvement of both tremors and bradykinesia. Patients tolerate this powder well but the major shortcoming is that large quantities of the drug are required to obtain a significant clinical benefit. However, the required bulk of *Mucuna Pruriens* presumably helps improve constipation associated with PD. *Mucuna Pruriens* is now commercially marketed as HP-200 in the form of a powder. An open label study in 60 PD patients evaluated the effects of HP-200 for a period of 12 weeks. The drug causes statistically significant improvement of patients with PD as assessed using the Unified Parkinson's Disease Rating Scale (UPDRS) scores. The common adverse effect was transient vomiting. The overdose of *Mucuna Pruriens*, according to the Ayurvedic texts, is headache, dystonia, fatigue and thirst. A recent study compared the use of *Mucuna Pruriens* in combination with *Hyoscyamus Reticulatus*, *Withania Somnifera* and *Sida Cordifolia* roots with and without cleansing therapy according to Ayurvedic principles. These authors' report significant improvement in the group undergoing cleansing therapy compared to those without cleansing therapy. This possibly validates the basis for cleansing of gut as recommended in the Ayurvedic texts.

Recently, Hussain and Manyam using the rat model of parkinsonism produced by intra-striatal injection 6-hydroxydopamine, demonstrated that *Mucuna Pruriens* endocarp has an anti-parkinsonian activity that is twice as effective than synthetic L-dopa. This study suggests that *Mucuna Pruriens*, in addition to, levodopa contains other unidentified compounds with anti-parkinsonian effects ."

As a patient I have been working with Herbal Drugs since last several years and I have mixed feelings on this subject although I do take alternative medicines, which are generally considered less harmful and have less side effects.

Herbs are nature's gifts and include leaves, barks, roots, seeds, stems and flowers and have been used successfully for many years. Our ancestors used them and which is why we too are using them today. Herbal medicine is the most ancient form of health care known to man. Herbs have been used in all cultures ever since historical records were kept. Herbal

medicine has had such an extra-ordinary influence that numerous alternative medicine therapists treat their patients with herbal remedies including Ayurveda. Unlike other systems, Ayurveda's main prescription depends on herbs only. Records of some of the oldest civilization such as the Egyptians, Persians, Hebrews and above all the Indian medical practices reveal that herbs were used to cure practically every illness.

Ayurveda focuses on the individual and not the disease. Even if someone is ill with specific symptoms, the treatment seeks to redress lack of balance in the three forces.

If alternative therapies had answers to all our problems, then why would the Western medicine ever be invented? I think it would be worthwhile to mention that a drug company typically spends US $ 802 million over the course of 10-15 years. Of every 5,000 medicines tested, according to the Pharmaceutical Research and Manufacturers of America, only five on the average are tested in clinical trials. Based on research by the Tufts Center for the Study of Drug Development, only one of these five is eventually approved for patient use. Bringing new drugs to the market is been an expensive, high risk R&D proposition and according to one study, the cost of development of a new drug in 1987 was estimated to be US $231 million.

Let us briefly examine some of the steps that a modern medical drug goes through before reaching the clinic. The drug should be safe, and effective for the proposed use, with minimum side effects, minimum toxicity. Benefits of the drug should outweigh its risks and low cost. In addition, the modern drug has to under go animal testing. These are the various phases that it undergoes during clinical trials:

Phase 1 : Studies are designed to determine the metabolic and pharmacological actions of the drug in humans and the side effects associated with increasing doses, etc.

Phase 2 : Includes the early controlled clinical studies conducted to obtain some preliminary data on the effectiveness of the drug for a particular indication, etc.

While on the other hand the dietary supplements or so called herbal drugs, the fastest growing business (US $12 billion industry) does not have to go through any of these tests.

The promising gleam in the future of herbal drugs is over shadowed by the gloom attached to a prevailing lack of regulatory control and the lack of purity, quality, strength, dosage and even assurance of botanical identity. There have been numerous instances of misbranding, adulteration and substitution that have been a detected in herbal drug resulting in lack of medicinal effectiveness and occasional poisoning.

The obvious question which then arises is, why are the alternative medicines are so popular? The question is challenging and search for answers is difficult. Perhaps some of the reasons are:

The media all too often dote on controversial and false claims but unfortunately provide few careful, critical examinations of them, usually preferring to titillate, pander, or entertain these claims. Often what the public hears is anecdotal testimony of people allegedly cured not the results of scientific research. Many best-selling books promote the power of such alleged healings, but they hardly pass the scrutiny of peer review. Several new journals devoted exclusively to "alter-

native" medicine have appeared recently, but they merely advocate unconventional treatments and rarely assess them objectively.

In Germany, perhaps a key factor is the feeling of unity with Nature (Natur-philosophie) required for action to be complete and satisfying. Add a tint of Hahnemann's homeopathy, Steiner's anthroposophical medicine, and a few mystical legends. In Britain, perhaps it is the tolerance of the unique, eccentric, and bizarre. In Asia, it is the sense of tradition and partnering of spirituality and cosmology with all phases of life.

The high incidence of side-effects with allopathic drugs, even with common over-the-counter drugs like NSAID's. Inability to find permanent cures for chronic diseases like Brochial Asthma, Diabetes, Arthritis, Cancer, AIDS, Parkinson's Disease, etc. It is in this scenario that "Herbal Remedies" come in the picture as most claim that they are "natural" and have the "Permanent Cure" for the disease. Patients cannot be blamed for consuming these herbal remedies as allopathic medicines have not proved to be effective enough to alleviate their sufferings. But what can you expect a Chronic Arthritis patient with skeletal deformities to do when Allopathic treatment cannot cure his condition completely?

There are many problems associated with any medication or product used by people looking for a solution, any solution for their real or perceived problems. What about the problems caused by reactions and interactions of "tested" pharmaceuticals? How many people, especially older ones, have been given prescription after prescription and suffered for it? How many doctors get their "latest" information from the drug company reps? How much does mainstream medicine "owe" to the big companies that fund all those conferences, giveaways, buildings, etc.,

People choose alternatives because they believe they need them. They are not confident with what is prescribed. Sometimes they feel much better using alternative approaches. I think everyone needs more information about what they are taking, self-prescribed or otherwise. We need access to more and better information and then perhaps we could choose more wisely from alternative products that are standardized and of good quality.

The industry of alternative medicine is growing and there are both sides of the stories as I have mentioned in this article. While on one hand this is perhaps the boon on the other hand an indiscriminate use of herbal drugs and without knowing their safety is dangerous.

Does Coffee's Caffeine Protect Against Parkinson's Disease?

On the same day actor Michael J. Fox officially announced the launch of a foundation for Parkinson's Disease research that bears his name, a new study was released showing that men who don't drink coffee are two to three times as likely to get the disease as are men who do not drink coffee and the more caffeine from coffee the men in the study consumed, the lower their incidence of Parkinson's Disease. For example, men who don't drink coffee at all were five times as likely to get the disease, as were those who drink seven cups, or 28 oz., or more each day.

I have tried almost all the alternative and regular drugs but I can only say that

perhaps dietary supplements like co-enzyme Q 10 and other antioxidants do help. I feel there is lot of potential in Herbal Remedies provided they are thoroughly scrutinized and have the same strict guidelines as allopathic drugs to qualify before they are introduced into the market. Moreover, more research needs to be encouraged into such kind of product, as they tend to have comparatively few side effects.

The issue of regular or alternative drugs is a matter of great debate and there has been claims made by different people. In this paper we have mentioned free radical theory and we still believe that antioxidant perhaps play a key role. There are two alternative therapies classical and conventional products based more on faith then research. The other one, which is more prevalent, deals with dietary supplements. Scientific groups at distinguished universities very well study some of which and numbers of them have gone through clinical trials also. These results are published in International Journals, but cannot be patented.

Free Radical Theory–Role of Antioxidants :

Free radical or oxidative injury may be a fundamental mechanism underlying a number of human neurological diseases. Therapy using free radical scavengers (antioxidants) has the potential to prevent, delay, or ameliorate many neurological disorders. However, the biochemistry of oxidative pathobiology is complex, and optimum antioxidant therapeutic options may vary and need to be tailored to individual diseases. Invitro and animal model studies support the potential beneficial role of various antioxidant compounds in aging process.

The potential involvement of free radical or oxidative damage in the pathogenesis of human disease has received an enormous amount of study in the last decade. Free radicals are atoms or molecules with unpaired electrons in their outer orbits, making them highly reactive with macromolecular structures, leading to cellular injury and homeostatic disruption. Free radicals are produced as a byproduct of normal metabolism and endogenous mechanisms exist to reduce their formation or enhance their inactivation. Disruption of the pro-oxidant and antioxidant balance in favour of the former may be a potential fundamental mechanism of human disease. A large body of evidence supports the concept that increased production of free radicals causes or accentuates neuronal injury and leads to disease, and this evidence has recently been reviewed by ourselves and others. Therapy aimed at boosting antioxidant defenses or reducing pro-oxidant production with free radical scavengers or anti-oxidants may be efficacious in preventing, ameliorating or arresting many neurologic diseases. This approach is receiving increasing attention in clinical neurology in large randomized controlled trials for common disorders. Moreover, widespread over-the-counter antioxidants and dietary supplements with presumed antioxidant ingredients has placed increasing pressure on physicians to be aware of data regarding the use of antioxidants as therapeutic agents.

Preventing Mitochondrial Decay

Mitochondria are tiny structures within the cells that convert nutrients into energy through the process of cellular respiration. Mitochondrial decay and the consequent decline in cellular energy production may be one of the most important causes of

cellular decline in aging. Now it is more or less certain enzymes like Coenzyme Q-10 and NADH play a key role.

Homeopathy

Based on the recent studies the author believes that even homeopathy may possibly have a solution and it is understood that Homeopathy treatment can be undertaken simultaneously along with Allopathy treatment. Consultation with an experienced homeopath is required for Parkinson's Disease. In a recent trial, a Homeopath has agreed to try their medicines in a single blind manner without disturbing the existing treatment.

A Response

Lack of herbal testing, it seems to me, would make doctors reluctant to prescribe herbs for depression. A doctor would hesitate to prescribe something that has not been scientifically proven through testing. Patients who are interested in exploring complementary therapies may become frustrated by what they perceive as reluctance on the part of their Primary Care Practitioner or Neurologist to support their use of these modalities. There may be several explanations for this hesitation. Probably the most significant reason is the paucity of research studies examining the effectiveness of these therapies. In order to determine that any treatment has an effect on a given disease, doctors are trained to demand evidence in the form of a placebo-controlled clinical trial. This means that certain aspects of a condition must be significantly altered in a group of patients who received the therapy compared to a group of patients who did not receive the therapy. Some complementary therapies may include factors that are difficult to measure such as reducing stress or an increased sense of well-being therefore designing an appropriate study to assess these benefits is often challenging task.

What is Co-Enzyme Q10?

Clinical trials conducted recently on Coenzyme Q10 and NADH support their benefit for Parkinson Disease Patient. A CoEnzyme Q10 is any of a group of relatively small organic molecules that make up the non-protein portion of an enzyme and without which—the enzyme is inactive. It is fat-soluble vitamin-like substance present in every cell of the body and serves as a coenzyme for important enzymatic steps of energy production in the cell. It also functions as an antioxidant. It is naturally present in small amounts in a wide variety of foods but is particularly high in organ meats such as heart, liver and kidney, as well as beef, soy oil, sardines, mackerel, and peanuts. To put dietary CoQ10 intake into perspective, one pound of sardines, two pounds of beef, or two and one half pounds of peanuts, provide 30 mg of CoQ10. CoQ10 is also synthesized in all tissues and in healthy individuals normal levels are maintained both by intake and by the body's synthesis of Co Q10.

Normal blood and tissue levels of CoQ10 have been well established by numerous investigators around the world. Significantly decreased levels of CoQ10 have been noted in a wide variety of diseases in both animal and human studies. Insufficient dietary CoQ10, impairment in CoQ10 biosynthesis, excessive utilization of CoQ10, may cause CoQ10 deficiency by the body, or any combination of the three. Decreased dietary intake is presumed in chronic malnutrition and cachexia. Normally 30-45 mg of CoQ10 is very useful for a normal person and is essential for a healthy life.

For that matter, what is an enzyme?

Enzymes catalyze biological processes and also create products (molecules) in our body which we need to survive. Enzymes can be compared with production machinery that turns one material into another one. Like gasoline is turned into horsepower.

In living cells, enzymes catalyze the breakdown and turnover of food into smaller usable units called glucose. It is enzymes that have prepared the fuel that the body uses for energy. Other enzymes transport the glucose (the fuel) into the cell. Once in the cell, it is coenzyme Q10 that converts glucose (the fuel) into energy. In other words, it is coenzyme Q10 that sparks the fuel, which creates the horsepower.

Enzymes can perform their work only if an additional coenzyme combines with the enzyme itself. Without the complementary coenzyme many enzymes do not work.

Since CoQ10 is essential to the optimal function of all cell types, it is not surprising to find a seemingly diverse number of disease states, which respond favorably to CoQ10 supplementation. All metabolically active tissues are highly sensitive to a deficiency of CoQ10. The deficiency in CoQ10 means that there is a reduction in the body's ability to remove free radicals.

The antioxidant or free radical quenching properties of CoQ10 serve to greatly reduce oxidative damage to tissues as well as significantly inhibit the oxidation of LDL cholesterol (much more "efficiently than vitamin E). This has great implications in the treatment of ischemia and reperfusion injury as well as the potential for slowing the development of atherosclerosis. In keeping with the free radical theory of Parkinson's Disease, these antioxidant properties of CoQ10 may have clear implications in the slowing of aging and age related degenerative diseases such as Parkinson Disease.

Until recently, attention has been focused on requirements for CoQ10 in energy conversion in the mitochondrial compartment of cells or on the antioxidant properties of CoQ10. New evidence shows that CoQ10 is present in other cell membranes. In the outer membrane it may contribute to the control of cell growth, especially in lymphocytes (the implications are far reaching). The clinical experience with CoQ10 in heart failure is good, and it is reasonable to believe that much of medicine should be re-evaluated in light of this growing knowledge.

Coenzyme Q10 (CoQ10) or ubiquinone is essentially a vitamin or vitamin-like substance. Disagreements on nomenclature notwithstanding, vitamins are defined as organic compounds essential in minute amounts for normal body function acting as coenzymes or precursors to coenzymes. They are present naturally in foods and sometimes are also synthesized in the body. CoQ10 likewise is found in small amounts in a wide variety of foods and is synthesized in all tissues. The biosynthesis of CoQ10 from the amino acid tyrosine is a multistage process requiring at least eight vitamins and several trace elements.

The other remarkable body products are:

NADH

NADH is the abbreviation used for Nicotinamide Adenine Dinucleotide, one of the most important coenzymes in the human brain and body. This coenzyme is

the active, or working form of a vitamin. NADH is the reduced (electron- energy rich) coenzyme form of vitamin B3, while NAD is the oxidized (burned) coenzyme form of B3. NAD and NADH are converted into each other in numerous different metabolic activities. In some metabolic reactions it is NAD which is the needed catalyst, with NADH a useful by-product, in other reactions the situation is reversed. NAD and NADH also serve to activate various enzymes, NAD for example, activates alcohol dehydrogenase and acetaldehyde dehydrogenase that are the two enzymes needed to detoxify the alcohol we drink, into carbon dioxide and water. NADH is the first of five enzyme complexes of the electron transport chain, where much of the ATP (the primary support of body energy) that runs every biological process of our lives is formed. Each unit of NADH is capable of generating three units of ATP energy. In a very real sense, NADH is the "energy of life" coenzyme.

Every living cell, from bacteria up to human, contains coenzyme nicotinamide adenine dinucleotide (NADH), a coenzyme critical to cellular energy production. Cells that use the most energy, such as brain and muscle cells, also hold the highest amounts of NADH. Human heart cells, for instance, contain a whopping 90 mcg of NADH per gram of tissue. Like Co-Q10, NADH is involved in the synthesis of adenosine triphosphate (ATP). When NADH is oxidized in cellular energy-producing organelles called mitochondria, it forms water and energy. This energy is preserved as ATP.

Every energy-consuming reaction requires ATP, so the more NADH a cell has available, the more energy it can produce. To keep up with the cellular demand for energy, the body continuously synthesizes NADH (a process that involves niacin, a B-complex vitamin). Although NADH occurs naturally in all plant and animal cells, its most plentiful sources are red meat, poultry and yeast. Vegetables are not as rich in NADH as animal tissues. Because food processing, cooking and stomach acids can destroy the NADH present in most foods, sprinkling yeast on meals is a good way to increase NADH consumption.

Melatonin :

Adults have an intrinsic body clock which regulates a complex series of rhythms including sleep and wakefulness, fatigue and cognitive ability. This endogenous clock naturally runs more slowly than the solar day and is linked to a 24-h rhythm primarily by the alternation of light and darkness. Jet lag, shift-work sleep disorder, and some of the chronic insomnias are caused by a temporal discrepancy of the body clock relative to the surrounding environment and social network. The underlying mechanisms and general management are described. Both bright light and melatonin therapy have potential in the management of these disorders. Traditionally, bright light therapy has been used to alleviate the depression associated with seasonal affective disorder. Melatonin has received much ill-formed publicity, it being claimed that it is a panacea and an 'antiageing' treatment. Both of these treatment approaches are reviewed.

Spirulina:

In India this famous blue green algae grown in natural lakes have been utilized since ages. Several papers have been published on its usefulness in AIDS, Cancer and the Immune System, reducing

Cholesterol, diabetes and hypertension, children and mothers and anti-aging strategy. Scientists from a number of research institutes and universities including the Department of Neurosurgery, University of South Florida and the University of Colorado in 2002 have published in the journal of neuroscience results from animal testing using diets supplemented with spirulina. This showed a significant reversal of neuronial degeneration associated with the spirulina antioxidant effect. Spirulina contains c-phycocyanin which is a non-toxic protein pigment isolated from the natural source namely spirulina platensis, a unicellular filamentous blue-green algae. This algae is considered as the natural food for the future. C-phycocyanin has the following remarkable properties.

Phycocyanin is used for treating internal or skin cancer. Once administered phycocyanin is selectively taken up into cancer cells and upon subsequent irradiation destruction of the cancer cells occurs. A photochemical method is known for treating atherosclerosis or cancer where in phycocyanin is injected into a patient suffering from one of these diseases. Phycocyanin is selectively taken up into atherosclerotic plaques or cancer cells. Phycocyanin offers several advantages over prior art chemicals used for similar purposes. Phycocyanin is an excellent photosensitizer and kills tumor cells. This property used for laser carcinosis curing. Since phycocyanin is nontoxic and safe, it can be orally administered. Phycocyanin helps preventing most of degenerative organ diseases by increasing general immunity. Phycocyanin has anti-inflammatory property. In animal experiments it has been shown to be a good anti-arthritic agent. Phycocyanin has been shown to prevent experimental oral cancer. It is a potent antioxidant and a radical scavenger. In fact it is better than many of the commercially available antioxidants. Phycocyanin protects and prevents chemical-induced liver injury. It also prevents fatty liver. Phycocyanin raises lymphocyte activity. It increases survival rate of cancer stricken patient. Phycocyanin could be used as a natural pigment for the food, drug and cosmetics industries to replace the currently used synthetic pigments which are carcinogens. It is used in anti-wrinkle cream, anti-pimple lotions and face masks.

GLA

GLA is the precursor to the body's prostaglandins - master hormones that control many functions. Dietary saturated fats and alcohol can cause in GLA (essential fatty acid) deficiency and suppressed prostaglandin formation. Studies show GLA deficiency figures in many diseases and health problems, so a food source of GLA can be important. Commercial sources of OPC's are grape seed extract and pine bark extract. Amazingly, OPCs do the same thing for all of your cells, protect them from free radical attack. OPGs also have a number of pharmacological effects that include inhibiting destructive enzymes such as, elastase, collagenase, hyaluronidase, and beta glucuronidase. The first two attack vascular networks and the skin proteins elastin and collagen. The last two enzymes attack joint fluids (hyaluronidase) and glycoproteins (glucuronidase) in cellular membranes.

Yoga

Yoga is a complex discipline practiced in India for over 5,000 years. The aspects

of yoga that have been broadly embraced in recent years primarily focus on the physical postures, which are called "asanas". Some of the potential benefits of yoga include improved strength and flexibility, stress reduction, and often a sense of psychological well-being. Most of the research on the health benefits of yoga has been done in India and has been directed towards conditions such as asthma, stress, and epilepsy. Within the next few years, there are sure to be studies completed in Parkinson's Disease as well.

There are many different styles of yoga? choosing the one that is right for an individual may require some investigation. However, now that classes are widely available in health clubs, rehabilitation centers, park district programs and community and senior centers, finding the right teacher and level of difficulty is becoming much easier.

Start with a basic, beginner class with an experienced instructor, preferably one that has the ability to modify the program for people with special needs.

Massage therapy

Massage therapy is the scientific manipulation of the soft tissues of the body for the purpose of normalizing those tissues and consists of manual techniques that include applying fixed or movable pressure, holding, and/or causing movement of or to the body.

Generally, massage is known to affect the circulation of blood and the flow of lymph. It reduce muscular tension or flaccidity, effect the nervous system through stimulation or sedation, and enhance tissue healing. These effects provide a number of benefits viz. reducing muscle tension and stiffness, relief of muscle spasms, improve flexibility and range of motion, increase ease and efficiency of movement, relieve stress and helps relaxation, promotion of deeper and easier breathing, improvement of circulation of blood and movement of lymph relief of tension-related conditions, such as headaches and eyestrain, promote faster healing of soft tissue injuries, such as pulled muscles and sprained ligaments, and reduction in and swelling related to such injuries reduction in the formation of excessive scar tissue following soft tissue injuries, enhancement in the health and nourishment of skin improvement in posture through changing tension patterns that affect posture, reduction in stress and an excellent stress management tool creation of a feeling of well-being reduction in levels of anxiety, increase in awareness of the mind-body connection and promotion of a relaxed state of mental awareness.

I sincerely feel the only way of retaining the credibility of this ancient and natural system of medicine and keep the quacks from misusing it, is by making "Alternative Medicine" a Post Graduate degree course. This way Doctors can recommend these products to carefully selected patients if allopathic drugs are unsafe/ineffective.

Recently the Drug Controller of India has at least introduced certain basic GMP (Good Manufacturing Practice) requirements for organizations engaged in herbal medicines or dietary supplements but how much of that is followed is still to be seen. We should be very careful that the propaganda, cultural relativism and other post modern doctrines that challenge objectivity are thoughtfully counted "for

today deconstructions are integral to anti-scientific thinking".

Alternative medicine proponents reject or misuse most criteria for evaluating validity. Their predecessors, the holistic medicine proponents, claim that an adequate view of medicine—i.e., health and disease—must include aspects of mind, spirit, and culture to be complete. Alternative proponents claim that contemporary biomedicine does not include psychological and claim that contemporary biomedicine does not include psychological and social matters. They intentionally denegrate or down play one aspect of biomedicine – research –and importune their readers to equate the word "reductionist" with the actual practice of medicine. But the practice of medicine has always been, by its nature, holistic. Alternative medicine advocates conveniently forget that the fields of psychiatry, psychology, social and preventive medicine, and public health are integral parts of modern biomedical practice, as is cooperation between physicians and clergy, as manifested by the presence of chaplains in most hospitals.

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Trends in mesoscopic transport

Colin Benjamin* AND A. M. Jayannavar

Institute of Physics, Sachivalaya Marg, Bhubaneswar-751 005, Orissa, India.

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Abstract

Mesoscopic physics is the area of solid state physics that covers the transition regime between macroscopic objects and the microscopic atomic world. In this regime electron retains its phase coherence throughout the entire sample. At low temperatures mesoscopic systems exhibit a wonderful new range of unexpected quantum phenomena. In this article a brief sketch of this field is presented and we restrict ourselves to the basic physics involved.

(Keywords : mesoscopic physics/Aharonov-Bohm effect/shot noise/ spintronics)

I. Introduction

The thrust of nanotechnology nowadays is to make new devices which occupy less space, can contain more information and are also cost effective. The trend towards miniaturization started with the invention of the world's first transistor[1] in 1947. Since then the size of devices have steadily shrunk, coming down to the micrometer scale in the 1980's. This drive for further miniaturization will lead us into the world of nanoscience. This will not only have major implications on future electronic quantum devices but also on fundamental issues in quantum physics, namely decoherence, entanglement and non-locality, etc[2], which will be mostly emphasized in the rest of the text. Furthermore most of these basic issues would be probed by simple experiments in the mesoscopic regime involving little more than a resistance measurement. We in this article will look into a few of the phenomena which have generated a lot of interest in the community. First we will present some of them which are characteristic to mesoscopic physics, and in subsequent sections we will discuss Aharonov-Bohm interferometry, persistent currents, current-magnification, shot noise, spin-polarized transport, quantum adiabatic transport (a new mode of transport), and finally testing basic laws of thermodynamics in nanoscale systems.

II. Mesoscopic Systems

Mesoscopic systems have sizes larger than atomic dimensions but comparable to or less than the *phase coherence length* L_Φ. This is the typical length on which a wave packet can travel without losing its phase coherence. L_Φ increases with decreasing temperature and is a measure of the inelastic mean free path, which in turn depends on coupling of electron to other environmental degrees of freedom. Here

the environment consists of phonons, electromagnetic fluctuations, other electrons, magnetic impurities, among other possible excitations. If system size is larger than L_Φ we recover classical behavior observed in macroscopic systems. As one tunes the temperature for a fixed length of the mesoscopic sample one can observe quantum effects at low temperatures which cross over to classical results at high temperatures. All of the observed phenomena, most often counter-intuitive, seen in mesoscopics are due to quantum interference, the number of electrons being even/odd, discreteness of charge, and in conductance measurements, whether there are two or more probes matter. Some of the observations include :

Breakdown of Ohm's law : In the classical domain, if one adds two resistors with resistances R_1 and R_2 in series then the total resistance (R) of the system is $R = R_1 + R_2$. However, this simple rule of addition breaks down in the quantum regime because of the phase factor which comes into play. Similarly the classical law of parallel addition of two resistors also breaks down. This can be readily understood with the new formalism of quantum transport (Landauer-Büttiker formalism) .

Within this formalism a mesoscopic system as a whole is treated as a single coherent scatterer, characterized by its global emergent properties (for example transmission coefficient T). The voltage and current probes are treated at par. The two probe conductance formula for one dimensional scatterers (system) is given by $g = \frac{e^2}{h}T$. This formula is a special case of the more general multi-channel version. These channels arise due to finite thickness of the wires (various transverse modes). The non-vanishing resistance predicted by the two probe formula for a 'perfect conductor' ($T \rightarrow 1$) actually represents an ideal quantum contact resistance which is unavoidable in a measurement *via* a two probe configuration. This quantized contact resistance has been directly observed in semiconductor point contacts in GaAs heterostructures[5]. It may be noted that if two phase coherent scatterers with transmission coefficients T_1 and T_2 are added in series it follows that $1/T \neq 1/T_1 + 1/T_2$ where T is the total transmission across the combined system. This explains the non-additivity of resistances using two probe formula. In low dimensional systems the total transmission (conductance) across the sample is extremely sensitive to the exact location of scatterers, even by interchanging two non-identical scatterers or by moving a scatterer by a few Å, one can change the conductance of a sample by several orders of magnitude[6]. Thus conductance contains the fingerprints of the underlying microscopic realization of configuration of atoms.

The generalization of the above two probe formula to the multi-probe configuration was done by Büttiker[7]. This explains several interesting observations in four probe conductance measurements especially the experimentally observed violation of Onsager's reciprocity relations, i.e., the four probe resistance is not symmetric under flux reversal.

Negative four probe resistance : The four probe resistance as mentioned above can be negative (which is indeed surprising). However, this does not violate any physical principle and the total loss (or dissipation) in the system is always positive.

Non-local current voltage relationship : Once again on the four probe set-up, if the current and voltage probes do not overlap and are very much spatially separated, then classically we do not expect any voltage drop across the voltage probes, but this is really what is observed. It arises because, electrons due to phase coherence are able to explore the entire system available to them (quantum non-locality at work).

III. Aharonov-Bohm Interferometry and Quantum Measurement

In 1959, Aharonov and Bohm published[8] a simple gedanken experiment. The authors predicted that the partial waves of a charged particle enclosing an electrostatic or magnetic potential experience a phase shift, even if the electric or magnetic field vanishes in the region of non-zero probability density. Interferences as a function of the relative phase shift occur which are known as the electrostatic or magnetic Aharonov-Bohm (AB) effect, respectively. In Fig. 1, an experimental set-up suited to test this prediction is shown. A ring is patterned out of a metal or a two dimensional electron gas, with a circumference smaller than the phase coherence length[9].

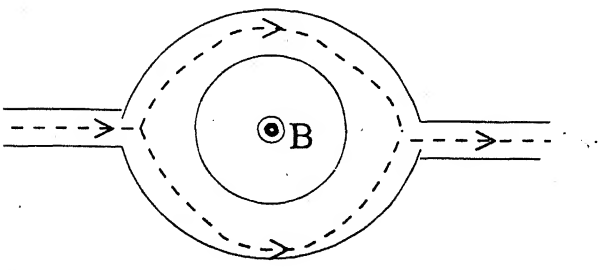

Fig. 1– Sketch of a sample used to study the AB effect. From Ref. 9

Consider a conducting ring enclosing a constant magnetic field **B** perpendicular to the plane of the ring. Of course this was not exactly the original proposal by Aharonov and Bohm, since the branches are penetrated by **B**. For very narrow arms compared to ring diameter, however, this modification is irrelevant. The phase collected by electron wave function during their passage through branch j of the ring (j denotes the upper(1) or lower (2) semi-circle) is given by $\Phi_j = \frac{e}{\hbar}\int_j A d\Gamma$, where A is the vector potential. The total phase difference between the paths $\Phi_1 - \Phi_2$ equals $\frac{eBS}{\hbar}$ which is tuned by the magnetic field. S denotes the area enclosed by the ring, and Γ is the parameterized trajectory. The total transmission probability T is obtained by summing up all the probability amplitudes and calculation of the square of the absolute, which being the two terminal conductance is symmetric in flux $\phi = B.S$ reversal and periodic with the fundamental flux periodicity $\Phi_0 = \frac{hc}{e}$. This periodic oscillation (interference pattern) of transmission (conductance) has been observed experimentally in many systems[11]. This observation of normal state AB effect has in itself led to a specialized area namely Aharonov-Bohm interferometry. Such an interferometry is of particular interest when propagating electron experiences electronic states in a quantum dot (or dots) kept in its arms, the interference pattern provides information about the physical properties related to electron correlations inside the quantum dot. Proposals for quantum devices are based on such interferometric principles. It is important to note that presence of static randomly distributed non magnetic impurities do not destroy the

interference patterns as they do not destroy the phase coherence of electrons.

Resonances : Transmission resonances are generally of two types Breit- Wigner and Fano. Fano line-shapes are asymmetric as opposed to the symmetric Breit- Wigner line-shapes. In contrast to Breit-Wigner forms, Fano resonances are characterized by zero-pole pair structure in the complex energy plane of the scattering amplitude[12] and these arise because of the two alternative paths possible, one through the resonant state and the other through the continuum. Fano effect has been observed in mesoscopic systems in transport experiments concerning an Aharonov-Bohm ring containing a quantum dot. The arm with quantum dot provides a resonant path while the other arm provides the direct path[13]. In the AB ring with quantum dot set-up, a resonance attributed to a purely many body effect (Kondo resonance) has also been observed and analyzed. It is quite well known that resonance states are characterized by phase jumps in scattering wave across a resonance. It is remarkable that using AB interferometry one is able to measure these phase changes of the quantum wave during scattering processes which were earlier unthinkable[14].

Measurement : Interference patterns from two slit experiments have been observed since the 19th century starting from the remarkable experiment of Thomas Young. Of course now we know that not only light can be made to interfere but also atoms, electrons, excitons and other exotic particles. However, a strange question has enchanted scientists, what happens if we determine through which slit the particle passed. What happens can be easily guessed, the interference pattern disappears (principle of complementarity), but what if we try to erase this information, *i.e.* through which slit the particle passed, it turns out that indeed one recovers the interference pattern. This has already been shown in experiments with lasers, photons and excited atoms. The corresponding proposals in mesoscopics use AB interferometers[15]. Recently experiments have been conducted to study a controlled dephasing mechanism by a which path detector measurement. For this one employs an AB interferometer with a quantum dot in one of its arms. A point contact serving as which path detector was fabricated near the quantum dot. The quantum dot and quantum point contact are very weakly coupled and they are spatially separated systems. Passage of electron through the quantum dot influences the conductance of the quantum point contact. Thus quantum point contact serves as a which path detector[14]. The visibility of AB oscillations was used to find extent of dephasing induced by the detector. These experiments of controlled dephasing *via* measurements are important in the area of quantum computation, where ultimately we have to readout the information contained in the quantum system by a measurement with quantum detectors which itself induces unwanted decoherence.

IV. Persistent Currents and Current-Magnification

It is well known that spontaneous currents which never decay can flow in super-conducting systems in absence of magnetic field. In 1983, it was predicted[10] that, a normal metal ring threaded by an A-B flux ϕ, in the phase coherent domain carries persistent currents, which is another manifestation of the AB effect. These arise because the magnetic flux breaks the time

reversal symmetry, inducing currents. At zero temperature in a ballistic (clean) ring of circumference l the amplitude of persistent current is given by $\frac{ev_f}{l}$, where υ_f is the Fermi velocity. For spin-less electrons, the persistent current can be either diamagnetic or paramagnetic depending upon whether the total number of electrons present in the isolated ring is odd or even respectively. This behavior is known as the parity effect. Experimentally persistent currents have been observed[11] but the last word on the subject has still not been written. This is because the discrepancy between theoretically predicted and experimentally observed magnitude of the persistent currents vary by two orders of magnitude.

What is current magnification? In inset of Fig. 2 for the non-equilibrium situation plotted, we see that the transport current I flows through the system when voltage bias is applied ($\mu_1 - \mu_2 = eV$). The upper and lower arms of the ring are of different lengths such that currents I_1 and I_2 flow in these with $I_1 \neq I_2$, but $I = I_1 + I_2$ i.e., Kirchoff's law is valid. In particular we see that for some ranges of Fermi energy I_1 or I_2 can be much larger than I ! Current conservation thus dictates I_1 or I_2 to be negative, respectively. This property that current in one of the arms is larger than the transport current is referred to as current magnification effect[16]. It is an effect without any classical analog. The negative current flowing in one arm can be interpreted as a circulating current that flows continually in the ring. The magnitude of the negative current in one of the arms flowing against the direction of applied current is taken to be that of the circulating current. Interestingly this circulating current can lead to a large orbital magnetic moment in absence of magnetic field, however in a non-equilibrium situation. We have investigated a quantum mesoscopic double ring system (Fig. 2). One must, however, note that while the inset describes a non-equilibrium situation, in this case we consider the system to be in equilibrium. The rings JIJ2aJ3Jl and JIJ2bJ3Jl enclose a magnetic flux, the bubble J2bJ3aJ2 does not enclose magnetic flux. But in the bubble circulating currents can arise due to current magnification. This effect is particularly important in testing thermodynamic principles in mesoscopic systems which will be discussed later.

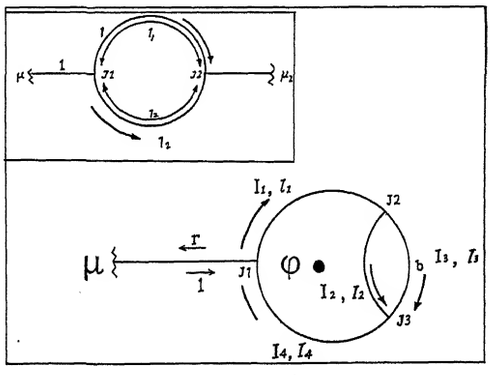

Fig. 2– The hybrid ring system connected to a reservoir at chemical potential μ. The bubble is denoted by the structure J2bJ3aJ2.The localized flux Φ penetrates the ring. The current densities in various parts of the structure are denoted by *I*'s while the lengths of the various regions are denoted by *l*'s. In the inset we have shown the non-equilibrium case, a one dimensional mesoscopic ring with leads is connected to two reservoirs at chemical potentials μ_1 and μ_2.

V. Shot Noise

Shot noise research is another active area in mesoscopic physics. It touches upon such fundamental topics of physics such as

entanglement and Bell inequalities[17]. In the presence of transport current one can observe current fluctuations due to discreteness of electrical charge known as shot noise. The macroscopic metallic conductor exhibits thermal noise but no shot noise. The shot noise is possible only in the phase coherent systems. At that scale shot noise can reveal a rich variety of information about the nature of electronic system, as opposed to the thermal noise which contains information about the temperature and conductance only. Below we mention some uses of shot noise measurement.

Measuring value of transferred charge : One can measure the value of transferred charge from the spectral density of the noise power. It may happen that the granularity of the current is not the elementary charge, but some fraction/ multiple of it. One cannot tell this from measuring the mean current, but from the shot noise power. In fact the first direct evidence of a fractional charge of the quasi particles, predicted in the theory of fractional quantum Hall effect came from shot noise experiments.

Shot noise can also detect entanglement : A multipartite state is entangled if it cannot be factored into a product of single particle states. Entanglement is the primary resource in quantum computing. Electron-electron interactions can lead quite naturally to an entangled state. Entanglement in the many body electronic state can be deciphered with the help of current cross correlations in multi terminal systems. The important point is that only the symmetry of the spatial part of the wave function matters for the noise. These measurements are an analog of the optical Hanbury-Brown and Twiss experiment.

Measurement of shot noise can distinguish dynamics of a particle in a mesoscopic system being deterministic or stochastic. For a readable account on shot noise we refer the reader to Beenaker and Schonenberger[17].

VI. Spin-Polarized Transport

Spintronics stands for spin electronics, i.e., manipulating the electron spin to our advantage. Quantum transport is generally confined to electrons at or near the Fermi level. Normal metals, e.g., copper have equal number of electrons with up or down spins, therefore it has no net moment and as a consequence the electrons at the Fermi level are unpolarized[18]. Ferromagnetic metals are not so, they have an exchange splitting between up and down spin states. Thus electronic current is spin-polarized. But why is spin-polarized transport so prized? The reasons are due to an unique property of spin which places them partly beyond decohering forces (namely electron-electron interactions) which are ubiquitous in all proposed devices at mesoscopic lengths. Of course it is not completely shielded, the electron spin interacts through the exchange coupling with other electrons in the vicinity of a magnetic atom or *via* spin-orbit coupling to impurity atoms or defects. In absence of these influences the orientation of electron spin may be very long-lived, even though the carrier may undergo many scattering events. The problem with these ferromagnet-normal metal junctions is that although they are good switches and valves they do not provide amplification plus they have problems in being integrated with the traditional semiconductor technology. To obviate the above problems with these structures, search began for a

semiconductor based spin transistor. In 1989, a spin transistor based on a conventional field effect transistor was proposed[19]. In this device, a two dimensional electron gas(2DEG) structure placed between two ferromagnetic electrodes provides the conducting channel. Its construction resembles that of a conventional FET, as the two ferromagnetic electrodes act as the source and drain respectively. The proposed device uses an electric field applied to the 2DEG to modulate the spin of carriers due to the Rashba spin-orbit effect. If the drain magnetization is parallel to the source magnetization and carriers make an integral number of precessions then spin conductance is large, if on the contrary carriers make non-integral number of precessions then spin conductance is low. Thus the electric field applied by a gate voltage effectively controls the conductance. This device is most visible for large spin-orbit interactions, where a electric field due to the gate has a relatively large effect on electron spin[19]. This acts as a spin filter or spin switch. There are several proposals for quantum devices based on the information carried by spin and not by charge. However, a true spin based device is yet to be convincingly experimentally demonstrated.

VII. Quantum Adiabatic Transport

Electronic current is usually a non-equilibrium phenomenon aided by a voltage bias. Quantum pumping is a new means of transferring electric charges in absence of bias. In quantum pumping, periodic ac perturbations of the system yield a dc current. In a recent experiment[20], the cyclic change of the shape of the quantum dot enables the flow of electric current in the absence of bias. The change of shape is adiabatic, which is very slow compared to relaxation time of electrons. If periodic deformation depends only on a single parameter, one cannot have net transport. As the interference patterns are random, the direction of current flow is random and is for instance sensitive to small changes in applied magnetic field, providing evidence of the quantum nature of the effect. Due to the adiabatic modulation in the shape of the confining potential, the phases and the spatial distribution of the wave-functions of the electrons changes. As a result the spatial density profile of the electrons changes. From the continuity relation variation of the charge density in time requires currents in the system. Thus a DC current is generated by periodically oscillating two independent parameters of the system that can change the potential profile with a fixed phase difference[21]. This type of transport generation accompanies small dissipation of heat and may play an important role in future electronic architecture. Presently quantum adiabatic transport has been extended both theoretically as well as experimentally to spin and heat transport[22].

Classically, also currents can be generated by cyclic adiabatic variations of at least two parameters of the periodic potential in absence of bias. Basically this is a mechanism of operation of a reversible ratchet or Brownian motor (heat engines at molecular scale). The theoretical work in these ratchet systems is motivated by biological motors which generate unidirectional motion in absence of bias by rectifying non-equilibrium fluctuations in the surrounding medium. Quantum and classical adiabatic transport are of entirely different origin[23].

VIII. Testing Ground for Apparent Violations in Basic Laws of Thermodynamics

Mesoscopic systems have also been proposed to provide a testing ground for verifying the apparent violation in the basic laws of thermodynamics[24]. This behavior has been explained by taking recourse to the effects of entanglement, through which the quantum system is so interlinked with the bath that the resulting behavior of the system alone cannot be treated within a conventional thermodynamic approach. Here the finite coupling between the bath and the system plays a crucial role. It should be noted that equilibrium thermodynamics of the super-system comprising of sub-system (system) plus bath, does not imply standard equilibrium thermodynamics for the sub-system alone. It is typically taken for granted that when going to quantum regime the classical Gibbs distribution is replaced by its quantum analog. This is true when system is coupled very weakly to the bath. Further, when this coupling is not weak (which is usually the case) the Gibbs state of the total system (sub-system+bath) leads to a non-Gibbsian state for the sub-system after tracing out the irrelevant degrees of freedom of the bath. This endangers equilibrium thermodynamics in the quantum regime. This does not happen for the classical case. Thus there appears an apparent violation of thermodynamic statements related to entropy, heat and work, etc[24]. For example, Clausius inequality can be violated, entropy production in the relaxation dynamics of the quantum system can be negative and the Landauer bound for the amount of heat required to erase one bit of information can be violated, etc. In-fact the thermodynamic equilibrium properties of the system depend on the coupling parameter, unlike conventional equilibrium statistical mechanics. For example, it has been shown that the mean orbital magnetic moment, a thermodynamic property, is determined by the electrical resistivity (which is related to system-bath coupling parameter) of the material[25]. What is crucial for dissipative diamagnetism is that system-bath interaction has to be treated exactly, there is no clear cut separation between what is the system and what is the bath, both are inexorably linked to one many-body system. We also have, motivated by the above results, provided a simple example wherein the equilibrium properties are determined by the system-reservoir coupling parameter in a *non-trivial manner.* For this we have studied the persistent current densities in a quantum double ring system, (which exhibits quantum current magnification, mentioned earlier, see Fig. 2) coupled to a reservoir *via* a simple voltage probe method due to Büttiker[26]. We have shown that when the coupling parameter between system and reservoir is very small there is perfect agreement between the magnetic moments calculated from the local currents (*via* Amperes law) and that from the derivative of free energy with respect to magnetic field. Increasing the strength of coupling parameter however leads to disagreement between the two[27]. This clearly brings out the role of coupling parameter between system and bath in determining equilibrium properties of the sub-system in the mesoscopic domain.

IX. Conclusions

In this article we have given a brief account of a few aspects of mesoscopic transport. Several phenomena related directly to transport like non-linear

response, weak localization effect, universal conductance fluctuations and mesoscopic superconductivity have not been discussed. Moreover, we have not dealt with many other interesting phenomena of nano systems related to optical, mechanical and magnetic properties. Furthermore we have excluded from our purview many new proposals for quantum devices, which rely on quantum effects for their operation and are based on interferometric principles. In contrast to conventional devices which operate by changing the carrier density, quantum devices operate by controlling the phase of the wave-function. These devices can be exploited only if one achieves the technology that can reduce or control the phase fluctuation to a small fraction of π. Practical realizations of quantum devices seem to be a distant possibility due to the intrinsic decoherence and extreme sensitivity to few impurities (sample to sample variations).

Experiments have been the driving innovative force in nanoscale work in the last two decades. With available technology one can controllably fabricate, manipulate and examine structures on the nanoscale. Very few phenomena we have described were predicted in advance of experimental observations. It of course will not be a surprise if experimentalists come up with new devices. Infact prospects of certain devices based on Coulomb blockade like single electron transistors where one can control electron transport one by one, and those based on resonant tunneling phenomena seem to be more promising. We are sure that this thriving area of research will lead to furtherance of our understanding of fundamental issues in basic science and technology.

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Ethics of scientific publications

S. P. Gupta

Department of Chemistry, Birla Institute of Technology and Science, Pilani-333031, India.

Email:spg@bits-pilani.ac.in

In the modern era, the advent of electronic facilities has tremendously increased the speed and hence drastically reduced the cost and time of printing and publishing. Consequently, there has been tremendous increase in the number of journals and periodicals meant for publishing the research outcome of the scientific community and nowhere it is going to stop. In addition to hard publishing, there are also now electronic journals that take much less time and are less costly than the hard publishing. Journals are published either by well known publishing houses e.g., Springer Verlag, Elsevier, John Wiley, North Holland, Bentham Science, etc., or by societies like American Chemical Society, Chemical Society London, Indian Chemical Society, Chemical Society of Japan, etc., or by some individuals. All journals fight for their survival; those that can afford their survival financially try to increase their standard but those that are financially weak afford their survival by publishing substandard or poor contributions and do much harm than good to the society. The research means to find the truth, to invent the new things, and to increase our knowledge about the universe. It becomes, therefore, the responsibility of a journal that it should publish the facts, new inventions, and the findings that add to our existing knowledge. All this in fact would depend upon the ethics that should be followed by publishers, editors, authors, and reviewers. American Chemical Society has time to time been publishing some guidelines for its society to maintain the standard of its journals. In the context of that and in the context of our Indian publications, certain guidelines are suggested that should be followed by all publishers to reviewers.

For Publishers

When any publisher, society, or an individual starts a new journal, it requires an editor. The selection of an editor should totally be unbiased and should depend upon his/her qualification. The editor must be quite knowledgeable about the subject of the journal, well established in his field, and quite familiar with other scientists in the field to be able to choose the relevant and competent reviewers for the papers submitted to the journal. In no case, the selection of editor should be by election as some of Indian journals do, or by virtue of one's position as most of the Indian journals do. The editor of a journal is the person responsible for the entire content of the journal. Owners (Publishers) and editors of journals have a common responsibility–the publication of a reliable and readable journal, produced with due

respect for the stated aims of the journal and for the costs. Editors must be given the full authority for determining the editorial content of the journal.

Also in constituting the editorial board, the election should not be preferred and no consideration should be given to one's position. In most of the Indian journals, the editorial board seems to be an ornamental piece of the journal with persons occupying high positions in their respective organizations and being little concerned with the standard of the journal. Such an editorial board proves of little value so far the maintenance or raising further the standard of the journal is concerned.

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2. All manuscript should be given unbiased consideration irrespective of race, cost, religion, nationality, sex, seniority, or institutional affiliation of the author(s).

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   Authorship credit should be based on: (1) substantial contributions to

conception and design, or acquisition of data, or analysis and interpretation of data; (2) drafting the article or revising it critically for important intellectual content; and (3) final approval of the version to be published. When a large multi-center group has conducted the work, the group should identify the individuals who accept the direct responsibility for the manuscript. The order of authorship in the manuscript should have the approval of all the authors.

All other contributors who do not meet the criteria of authorship should be listed in an 'Acknowledgements' section. Examples of those who might be acknowledged include a person who provided purely technical help, writing assistance, or a department chair who provided only general support. Financial and material support should also be acknowledged.

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For Reviewers

Unbiased, independent, critical assessment is an intrinsic part of all scholarly work. Peer review is the critical assessment of manuscripts submitted to journals and hence is viewed as an important extension of the scientific process. Therefore, a reviewer plays a very crucial role between the authors and the editor and has certain responsibility to maintain the credibility of the journal. Hence they should self impose the following ethics on themselves.

1. A selected reviewer should review the manuscript without any regard to race, religion, nationality, sex, seniority, or institutional affiliation of the authors.
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himself quite competent. If the paper does not belong to his area of research or by any reasons he does not find himself to be comfortable to review that paper he should return it promptly to the editor.

3. The comments on the manuscript should be given only after going through it carefully and should be quite objective with respect to the quality, originality, interpretation of the results, and the importance of the work.
4. If there is any conflict of interest between the reviewer and the author(s) of a particular manuscript submitted, the reviewer should immediately return that manuscript to the editor.
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These guidelines if followed by publishers, editors, authors and reviewers may certainly raise the prestige of any journal.

Conflicts of Interest Related to Project support

The research and research publications are mostly based on funding from commercial firms, private foundations, and government agencies. The conditions of this funding have the potential to bias and otherwise discredit the research. Funding agencies should be unbiased in judging the merit of any proposal submitted by any author or group of authors. The committee entrusted for this work should comprise of competent persons and each proposal submitted should be peer reviewed. A reviewer must follow the same guidelines as for a research paper. All proposals should be judged on its merit without any regard to race, religion, nationality, sex, seniority, or institutional affiliation of the authors. Government agencies often discriminate between proposals submitted from private organizations and those submitted from government organizations with least preference for the former. If the governmental agencies are committed to provide the funds to the private organizations, this discrimination is

uncalled for, but unfortunately it happens in India.

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Winter School on NMR spectroscopy at the frontier of progress in the life sciences: Jan. 19-31, 2004: Institute of Protein Research, Osaka University, Japan): A report

Girjesh Govil

Tata Institute of Fundamental Research, Homi Bhabha Road, Mumbai-400 005, India.

Email: govil@tifr.res.in

In recent years, NMR has contributed to the progress in all areas of life sciences. It is a major tool for understanding structure-function relationship of biological molecules, bio-membranes, drug-design and metabolism in cells and intact organs. However, the population of NMR scientists in Asia is very low compared to North America or Western Europe. The purpose of this school was to introduce young scientists from Asian countries to the Frontiers of NMR technology and their applications in diverse areas of life sciences. The idea for such a school came for the IUPAB Task Force on NMR. However, a major funding was provided by the Asian Development wing of the Japan Society for Promotion of Science (JSPS) and the Institute of Protein Research. Fifty post-doctoral fellows and young faculty members from China, India, Japan, Korea, Nepal, Pakistan, Philippine, Singapore, Taiwan and Vietnam participated in the school. All were fully supported for their travel and living expenses. The students came from diverse back-ground, but all had the desire to learn latest advances in biological NMR. This was the first school of its kind in Asia, though IUPAB has been involved in similar activities in Eastern Europe and South America.

During the first week, participants were exposed to basic principles of NMR as applied to life sciences as well as practical demonstrations. This was covered by instructors from Asia (Akutsu, Shirakawa, Ito, Yamazaki, Fujiwara, Takegoshi, Ikegami, Yagi, Ohkubo, Tate, Ikura, Chary, Han, Yang and Govil). Each student was asked to give a poster on the work he/she is doing. In second half, participants were exposed to advance techniques and new developments by world leaders in the area of NMR in biological systems (Bax, Griesinger, Griffin, Markley, Guntert and Shimada). Each lecture was about 2 hours duration. A two-day symposium in the memory of (late) Prof. Kyogoku, a world-renowned NMR spectroscopist from Japan was also organized. Visits were organized to two major facilities for macromolecular research in Japan: Spring-8 and NMR park. A unique feature of the School was that each instructor was asked to give his lecture notes in advance, which were used to compile a text-book for the school.

I talked to almost all the participants. The impression I got was that they all learnt a great deal from the school. To those who had no previous exposure to the field, the lectures provided them with an opportunity

to get into this interesting frontier of science. For those who are already in the field, it gave an opportunity to interact and learn about the latest advances from the world leaders in the field. Everyone appreciated the seriousness with which the course was conducted. Prof. Akutsu, Prof. Kainosho and their teams did a wonderful job of not only organizing instructions in the form of a well-chalked out program but also in taking care of the personal needs of the participants. There was enough time for discussion and also very close interaction between the senior and the younger scientists during the breaks. The school also created an international brotherhood among the young scientists. The tour of the two facilities enabled young researchers from developing countries to learn about the opportunities that Japan can provide for higher studies. There was a general feeling that we need more such schools.

I wish that we follow a similar pattern while organizing winter/summer schools and workshops in India.

Repellent effect of ethanol extracts from plants of the family Lamiaceae on Colorado Potato Beetle adults (*Leptinotarsa decemlineata* SAY)

Roman Pavela

Research Institute of Crop Production, Drnovská 507, 161 06 Praha 6-Ruzyně, Czech Republic

email: pavela@vurv.cz

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Abstract

The effect of ethanol extracts, from 9 plants of the family *Lamiaceae* applied on potato leaves, on the feeding behaviour of adult individuals of Colorado potato beetle was studied in laboratory. Extracts of *Salvia splendens, Origanum majorana, Hyssopus officinalis, Salvia officinalis* and *Marrubium vulgare* were strongly repellent (84-98 % repellency). *Thymus vulgaris, Ocimum bassilicum* and *Origanum vulgare* showed a medium repellency (61-74%) and *Mellisa officinalis* had a weak repellency (28%). After 24 and 48 hours there were 50 and 90%, respectively, of control leaves eaten. Leaves with extracts of *S. splendens, O. majorana, H. officinalis, S. officinalis* and *M. vulgare* showed long antifeedant activity as they were not eaten at all or a little (less than 7%) even after 48 hours of exposure. Leaves treated by *T. vulgaris* and *O. bassilicum* had a medium antifeedant activity - eaten by less than 28%. Finally, leaves treated by *O. vulgare* and *M. officinalis* showed weak antifeedant effect as being eaten by 46-71%.

(Keywords: Lamiaceae/botanical insecticides/ *Leptinotarsa decemlineata*/ repellent effect/plant extracts)

The use of synthetic pesticides has often a negative influence on environment and may cause a selection of resistant populations of pests, or a change in the spectrum and density of the natural enemies. The residues of some pesticides in food chains can be hazardous to human health. These and many other reasons force us to look for new alternatives for the protection of cultural plants against pests that would eliminate above-mentioned problems to a minimum. One of the possibilities is a use of the secondary metabolites of plants, which were developed during evolution as the component of natural defence against phytophagous insects. The study of the insect-plant interactions enables us to find the practical use for the protection of cultural crops. One of the most important issues is the study of factors that influence foraging behaviour of phytophagous[1].

A complex system of chemoreceptors evolved in phytophagous insects in order to find food. A large number of chemosensilla, with various characteristics

of sensitivity and specificity, provide foraging insects with information useful in making the decision to feed or not feed[2]. On the other hand, plants evolved a large array of defensive metabolites of a secondary character which show various biological activities against phytophags. Plant metabolites can be for some insect species poisonous, in other can affect hormonal activity and inhibit growth or can have an anti-feedant or a repellent effect[3]. The sensitivity of particular insect species to various sorts of plant metabolites varies. Polyphagous insects are less sensitive to them than oligophagous or monophagous ones. The level of the sensitivity of the insect species to plant metabolites is closely related to the ability to search for food[4].

Colorado potato beetle, *Leptinotarsa decemlineata* SAY (Coleoptera: Chrysomedlidae) is a frequent pest of potatoes, tomatoes and other plants of the family Solanaceae. Colorado potato beetle played an important role in the development of ideas concerning the role of plant secondary compounds as feeding deterrents[5]. Mitchell *et al.*[2,5,6,7] studied the influence of various factors and plant metabolites on chemoreceptors of Colorado potato beetle. They gave characteristics of galeal chemosensilla of adult *L. decemlineata* and described the role of chemosensilla in food selection. They studied the effect of plant alkaloids on chemosensory reaction of Colorado potato beetle and found that none of the alkaloids stimulated chemosensory cells in a dose-dependent manner although a few stimulated low-level activity in some cells. However, there was no evidence for a general "deterrent receptor" in these beetles. Some of the alkaloids had a marked inhibitory effect on normal chemosensory response, for example, mouthpart sensilla on the galea of both adult stages respond to leaf of plants, above all to L-alanine, gamma-amino butyric acid and sucrose[6,7]. The effects of secondary metabolites on chemosensory reactions of Colorado potato beetle have not been described sufficiently yet. Taking into account the fact that *L. decemlineata* is oligophagous, it can be sensitive to some plant metabolites, which can decrease the sensitivity of chemoreceptory cells. The aim of this study was to find how extracts from plants which contain metabolites applied on host plant change the ability of Colorado potato beetle to locate and identify food.

Plants of the family *Lamiaceae* are not belong a host plant of *L. decemlineata.* Biological activity of extracts from these plants was found for some representatives, e.g. *Ocimum americanum L.* Plant and leaf extracts of this species were found to protect the grains from storage insect infestation[8]. *Euproctis fraterma* showed toxicity to the hairy caterpillar[9]. Rajendran and Gopalan[10] reported that leaf and whole plant extract of *Ocimum sanctum* L. show an insecticidal activity to the 5th instar larvae of the cotton stainer, *Dysdercus cingulatus;* the 3rd instar larvae of the cotton leaf armyworm, *Spodoptera litura;* and a castor pest, *Pericalia ricini.* Volatiles from leaf extract were found to inhibit oviposition of the cotton leafhopper, *Amrasca devastans*[11]. Oil and leaf and flower extracts of *Lavandula augustifolia* Mill. was reported to show a repellent activity against the cotton aphid, *Aphis gossypii*[9]. Leaf acetone extracts of *Lavandula gibsoni* L. was reported to show an insecticidal activity against the cotton stainer, *Dysdercus koenigii*; the potato

tuber moth, *Phthorimaea operculella*; and the red flour beetle, *Tribolium castaneum*[12].

Repellent effects of extracts from plants of this family on *L. decemlineata* are known for *Ocimum basilicum* L.[9], and *Nepata cataria* L.[13].

Material and Methods

Extracts : Above-ground parts (before flowering) of *Salvia splendens* SELLOW, *Salvia officinalis* L., *Origanum majorana* L., *Ocimum bassilicum* L., *Marrubium vulgare* L. were homogenized in 90% ethanol, in weight ratio 5:1 (ethanol: plants). Mixture of solvent with plant homogenate was mixed for 24 hours at 300 rpm and room temperature of 25 °C. Extracts were then separated with the help of filtration. The extracts were kept in dark at 7 °C.

Insects: The adults of Colorado potato beetle were collected from a potato field that was not treated chemically. Before the establishment of this experiment the beetles were left for 24 hours without food.

Plants: Leaves from potatoes cv. Agria were used for the experiment. The leaves were of the same phenological age and size. Each leaf had three top leaflets. In order to prevent wilting the stems were inserted into porous hydrophilous material (?).

Methods: Extracts were applied as sprays separately on each potato leaf. Three treated leaves were put in a circle in an arena (Petri dish, 30 cm diameter), together with three control leaves (sprayed by ethanol) so that they did not touch mutually and were changed over. Each variant had 3 replications. Three adults of *L. decemlineata* were introduced to the centre. Arenas were covered by an entomological net. The experiment was run in an air-conditioned room under 25°C, L : D=16:8 and relative humidity 60-70%. The experiment was finished after 52 hours.

The number of beetles eating a leaf was recorded at one-hour interval (during the first 12 hours) and at 3-hour interval (for the rest of the experiment). There was no observation in the night. The damage of leaves was evaluated after each 24 hours by scanning the leaf area.

The percentage of repellency was calculated from the following formula (6)

$$\% \text{ repellency} = (C\text{-}E/C) \times 100$$

where C = number of beetles on control leaves

E = number of beetles on treated leaves

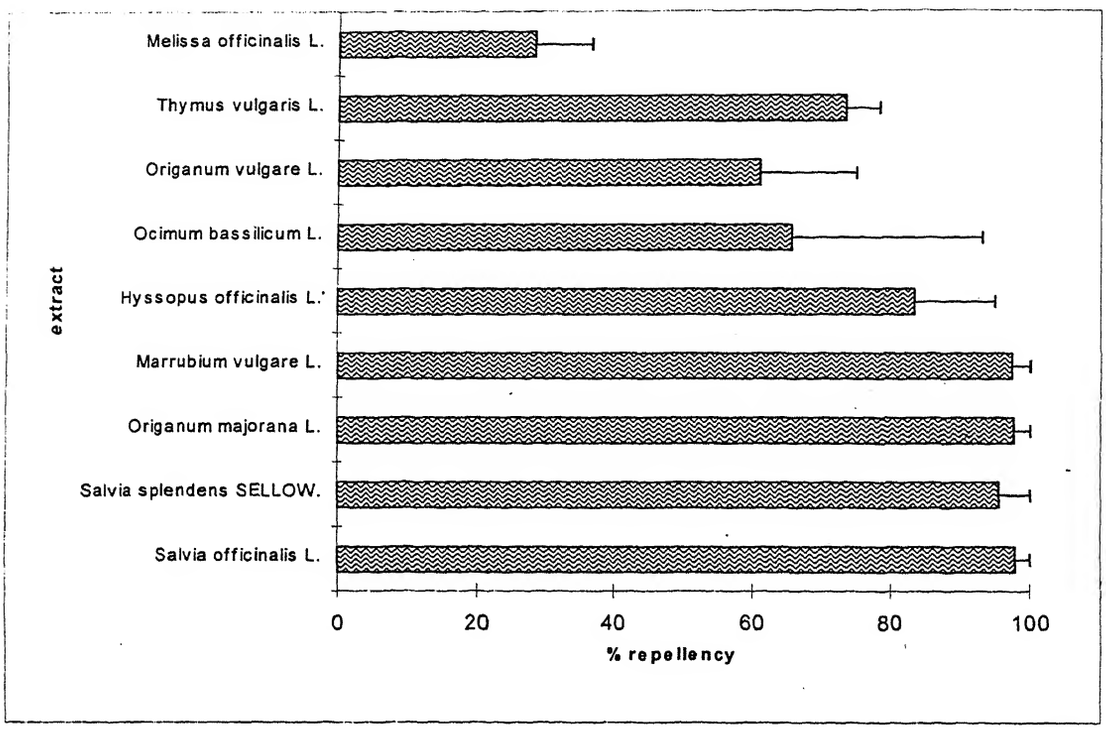
The Coefficient of Antifeedant Activity was calculated from the following formula

$$CAA = ((FC\text{-}FE)/FC) \times 100$$

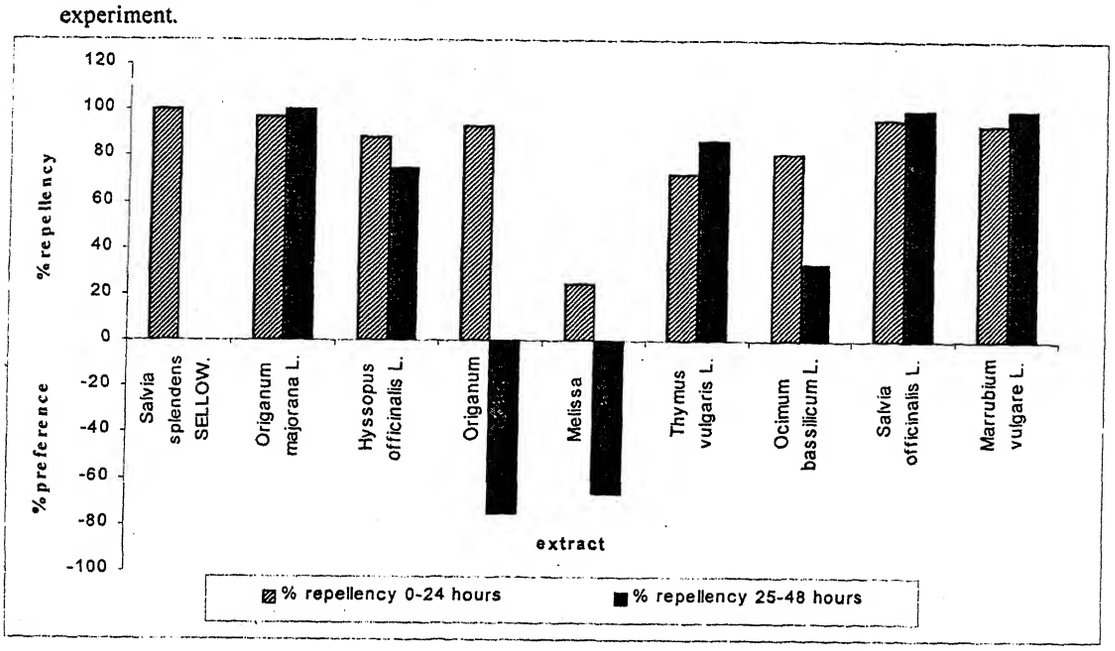
where FC = % of average damage on control leaves

FE = % of average damage on treated leaves

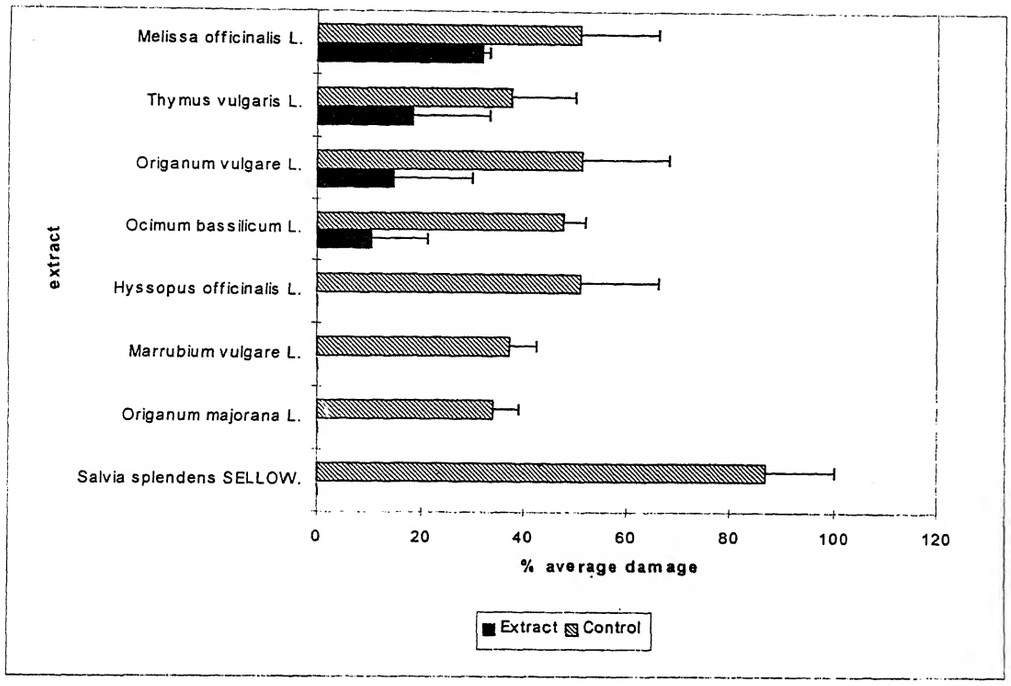
The data obtained as described above were processed in accordance with the standard methods and evaluated statistically applying the Analysis of Variance (Multiple Rangetest, One-Way ANOVA, method: LSD 95%).



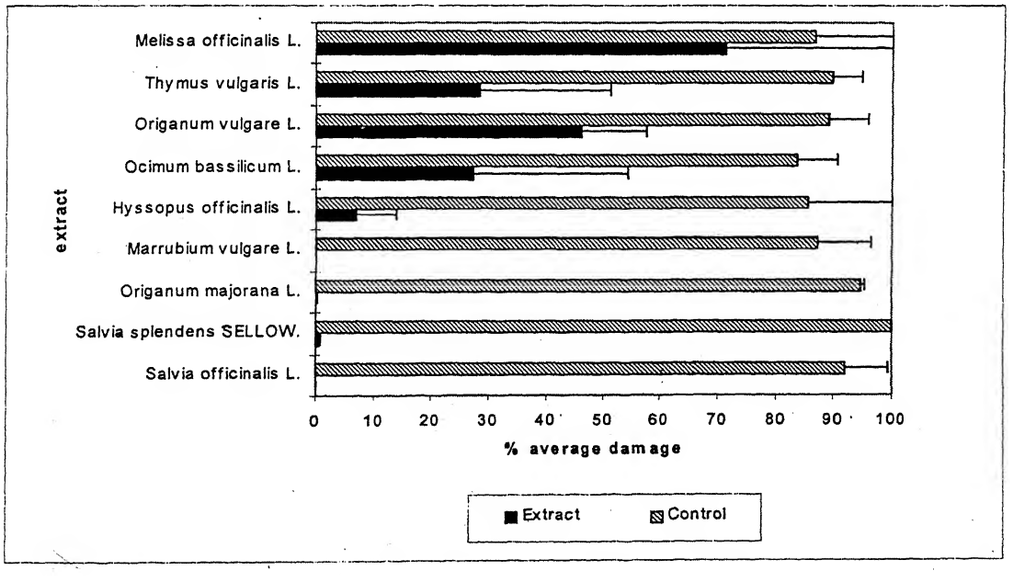
Graph 1– The average percentage of the repellency of the extracts on adults - 48 hours after the establishment of the experiment.



Graph 2 - Represents the development of the average percentage of repellency the first 24 hours and the second 24 hours from the establishment of this experiment.



Graph 3–The average damage by adults of Leptinotarsa decemlineata - 24 hours after the establishment of the experiment.



Graph 4: The average damage by adults of Leptinotarsa decemlineata - 48 hours after the establishment of the experiment.

The extracts of plant	24 hodin	S.D.	48 hodin	S.D.
Salvia officinalis L.	100[a]	0	100[a]	0
Salvia splendens SELLOW.	100[a]	0	99,7[a]	0,47
Origanum majorana L.	100[a]	0	99,8[a]	0,14
Marrubium vulgare L.	100[a]	0	100[a]	0
Hyssopus officinalis L.	100[a]	0	92,6[a]	5,74
Ocimum bassilicum L.	79,1[a]	16,8	69,1[ab]	24,6
Origanum vulgare L.	63,7[ab]	33,6	48,4[bc]	7,15
Thymus vulgaris L.	37,4[b]	51	67,1[ab]	22,5
Melissa officinalis L.	32,8[b]	18,7	20,4[c]	16,8

Results

Extracts from plants *Marrubium vulgare, Salvia splendens, Salvia officinalis, Hyssopus officinalis* and *Origanum officinalis* showed a high repellency (84-98%) during 48 hours after application (1). A medium repellency (61-74%) graph was found for extracts from *Thymus vulgaris, Ocimum bassilicum* and *Origanum vulgare.* The extract from *Melissa officinalis* showed a very low repellency (28%).

Graph 2 represents the development of the average repellency during the first and the following 24 hours from the establishment of the experiment. Extracts from *O. vulgaris, S. officinalis* and *M. vulgare* had a very high repellency during the entire period. Moreover, during next 24 hours the repellency increased to 100%. Extract from *S. splendens* had 100% repellency for the first 24 hours. During next 24 hours the beetles did not move to sprayed leaves with the exception of the first 6 hours. The repellency of *H. officinalis* extracts ranged between 70-90% during both monitored periods. For extracts from *O. vulgare, M. officinalis* and *O. bassalicum* the repellency gradually declined in the course of time. And extracts from *O. vulgare* and *M. officinalis* made the leaves more attractive during the second 24 hours.

Observed leaf damage is shown in graph 3 and 4. After 24 hours (Graph 3) about 50% of the control leaf area was eaten. For extracts from *O. bassalicum, T. vulgaris, O. vulgare* and *M. officinalis* the damage was between 15 to 32%. No damage was recorded for extracts from *M. vulgare, S. officinalis, S. splendens, O. majorana* and *H. officinalis*. After 48 hours (graph 4) 90% of the control leaf area was eaten. Leaves treated with extracts of *S. splendens, S. officinalis, O. majorana, H. officinalis* and *M. vulgare* showed a long

antifeedant activity as they were not eaten at all or a little (0-7%). Leaves treated by *T. vulgaris* and *O. bassilicum* had a medium antifeedant activity - eaten by less than 28%. Finally, leaves treated by *O. vulgare* and *M. officinalis* showed a weak antifeedant effect as being eaten by 46-71%.

Table 1 summarises estimated values of the coefficient of antifeedant activity. Extracts from *M. vulgare, S. officinalis, S. splendens, O. majorana* and *H. officinalis* showed high antifeedant effects, which ranged between 92-100%. The extracts from *O. bassilicum, O. vulgare* and *T. vulgaris* showed an effect of about 50%. A very low antifeedant effect was found for extracts from *M. officinalis.*

Discussion

Every plant species produces certain metabolites, which are typical and unique. The amount and the quality of metabolites appear to be the most important trait in recognition of host plants for phytophagouses[1]. During co-evolution various food specializations have evolved. Together with a food specialization, the chemoreceptory systems in insects was improved[4], as well as the sensitivity to plant chemicals increased.

The results of this study confirm that Colorado potato beetle is sensitive to some secondary metabolites of plants from the family *Lamiaceae*. Repellent effects of the extracts from plants of this family on Colorado potato beetle have been described, for instance, for extracts from leaves of *Ocimum basilicum* L.[9], and water extracts of roots, leaves and flowers of *Nepata cataria* L.[13]. Insecticidal effects of extracts gained from plants of the family *Lamiaceae* were observed for other pests[8,10-12].

In my experiments I found that extracts from some plants affected the ability to identify food in Colorado potato beetle. Drawing from the similarity in the effects of repellency and antifeedancy it is possible to put the studied plant species into 4 groups:

The first group includes *S. splendens, S. officinalis, O. majorana* and *M. vulgare.* Extracts from these plants showed high effect of repellency and high antifeedant effect during the whole period of the experiment. The second group includes *H. officinalis* and *T. vulgaris.* These extracts showed both high repellent and antifeedant effect which changed in the course of time. For *H. officinalis* the effect declined after 24 hours while for *T. vulgaris* the effect slightly increased. The third group includes *O. vulgare* and *O. bassalicum.* Their extracts showed high repellent and antifeedant effect only during the first 24 hours. Afterwards the beetles even preferred leaves treated by these extracts. The fourth group includes *M. officinalis* that did not show either repellent or antifeedant effect.

The results show that adults of Colorado potato beetles were most sensitive to the extracts from *S. splendens, S. officinalis, O. majorana* and *M. vulgare.* This sensitivity was expressed as repellent and antifeedant effect. It is possible that substances contained in these extracts prevented the chemoreceptory cells to recognize the leaves of potato as food. Secondary compounds are, of course, not the only phytochemicals, which act as feeding ?stimulants? for insects in general and chrysomelids beetles, in particular.

Mitchell[14] mentioned some chemical substances known to be feeding stimulants (L-alanine, sucrose, and GABA) or deterrents for adults of *L. decemlineata* (steroidal glycoalkaloides). Colorado potato beetle is oligophagous feeding on plants of the family *Solanaceae*, which contain a number of metabolites from the alkaloid group. It is possible that the beetle is tolerant to alkaloid substances, which do not cause a primary chemosensory response[5,15,16].

The results of our experiments show that the adults of Colorado potato beetle are sensitive to some secondary metabolites from plants of the family *Lamiaceae.* This sensitivity is probably caused by deterrent effects of these substances, which prevent manifestation of a primary chemosensory response to the feeding stimulus. Possibly this primary response is in progress via chemoreceptory cells on galeae. The cells on galeae are considered to be the important sensory organs for the potato beetle especially with respect to host recognition and feeding. Several studies strongly suggested this importance by demonstrating clear responses to various stimulants and deterrents alone or in mixtures[2,6,7,17]. Some studies also attempted to relate galeal sensory responses to the feeding behavior of the beetle on its host and non-host plants[18,19]. The hypothesis that feeding deterrents are the major factors in a (non)host-plant recognition has many bases in search for the mechanisms underlying oligophagy in *L. decemlineata*[14]

According to the results of this study it is clear that some of the secondary metabolites contained in some plants of the family *Lamiaceae* act repellently and antifeedantly on adults of *L. decemlineata.* A hypothesis is suggested that substances contained in these plants act on chemo-receptory cells, which are responsible for the correct recognition of host-plants by phytophagouses. The repellent effect of extracts of some plants was strong and outlasted. It comes out that the secondary metabolites from plants of the family *Lamiaceae* have a potencial for the use in control of this pest.

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Successful air layering in *Myrica esculenta* —a simple and clonal method of propagation

V. K. Purohit, S. K. Nandi*, L. M. S. Palni, N. Bag AND D. S. Rawat

G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora–263643, Uttaranchal, India.

e-mail: shyamal_nandi@rediffmail.com

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Abstract

The rooting ability of air layered shoots of *Myrica esculenta* Buch. – Ham. ex D. Don, a commercially important and difficult to root species, has been examined using different chemicals. Various concentrations (100, 500 & 1000 ppm) of auxins (IBA and NAA), and a systemic fungicide Bavistin (containing 50% Carbendazim) were applied using a soil paste to the shoots during the rainy season. The lower concentrations of IBA (100 & 500 ppm) only resulted in rooting (20.0 & 53.33% respectively, compared to no rooting in control shoots); the highest number of roots per air layered shoot was formed when 500 ppm IBA was applied. Clonal plants raised through this method have been successfully established in earthen pots.

(Keywords: air layering/ propagation/ auxins/ *Myrica esculenta*)

Myrica esculenta Buch. – Ham. ex D. Don, (Family Myricaceae), locally known as Kaiphal, is a dioecious, moderate sized, evergreen tree species. It is a characteristic associate of forests between 1000 - 2200 m amsl and valued for the wild edible fruits. The species is found in the Indian Himalayan region and its distribution extends to China, Japan, Malaya and Singapore[1]. In the Kumaun region of the Indian Central Himalaya it is a common associate of chir pine (*Pinus roxburghii*), banj oak (*Quercus leucotrichophora*), and also occurs in mixed forests and agricultural and marginal lands. The fruits are either eaten raw or consumed in a processed form, and the income generating potential of its fruits has been documented[2]. Besides, the species is considered an excellent source of fuel and scarcity fodder[3], as well as medicines[4], tannins[5] and oil[6].

Although natural regeneration of the species is through seeds, it is adversely affected by poor seed germination (30% or below), low seed viability among different populations (63 to 80%)[7], slow initial growth of seedlings and poor establishment under natural conditions, as also reported for other species of *Myrica*[8, 9]. While vegetative propagation using stem cuttings is a simple method of multiplying elite tree species, the same has been reported to be difficult in most species of *Myrica*[10] and has not been successful in *M. esculenta* also[7].

In view of the above, an attempt has been made to develop a simple and efficient propagation method of *M. esculenta* through air layering of mature shoots using auxins and a related compound.

The air layering (layering involves rooting of shoots without removing them from the mother plant) experiments were carried out during the rainy season (July, 2003) on 10 year - old trees growing in Katarmal forest (1250 m amsl), District Almora (Fig. 1A). Shoots (air layers) were treated with 100, 500, or 1000 ppm (w/w) of auxins (indole-3-butyric acid, IBA and α - naphthalene acetic acid, NAA; both from Sigma, USA) and Bavistin (containing 50% Carbendazim, a. i.; BASF India Ltd., Mumbai, India). A total of 15 shoots (30 - 40 cm length and 7-8 mm diameter with 10 - 15 leaves) were used for each treatment and for the untreated control. Following careful removal of the bark ring (3.0 cm wide) with the help of a sharp knife, about 30 - 35 cm from the tip of the current year shoots, various test chemicals (mixed with soil and used as paste; 10g soil per air layer) were applied at the girdle. The surface was then covered with moistened sphagnum moss and wrapped with a polythene sheet. Both the ends were tied with thread, and small holes made in the sheet to permit limited air exchange. Observations in respect of the root emergence were recorded at 15 days interval for a period of 65 days. Afterwards well rooted, air layered shoots were cut, below the girdle, with a sharp knife (Fig. 1 B and C), and transferred to earthen pots containing approximately 4 kg soil and farmyard manure (3:1, v/v); these plants were kept inside a mist chamber maintained at 25°C with 70% RH and receiving 70% sunlight, for hardening (Fig. 1D) for 4 weeks. Following this the plants were moved into the open, receiving full sunlight and the pots were watered periodically.

The root formation in air layered shoots recorded after 65 days is shown in Fig. 1. IBA at 500 ppm induced maximum rooting (53.33% compared to 0% in control, with an average of 10.12 ±2.50 roots per shoots with avg. root length of 4.49 ±0.46 cm) (Fig. 1B and C). The lowest concentration of IBA (100 ppm) resulted only 20.0% rooting with an average of 6.0 ±0.81 roots per shoot and avg. root length of 3.01 ±0.43 cm. The highest (1000 ppm) concentration of IBA and all other treatments (NAA or Bavistin) were ineffective in inducing root formation. IBA and NAA at 1000 ppm resulted only in the formation of callus at the girdle.

This study demonstrates an effective and easy method of clonal propagation of *Myrica esculenta* by air layering of mature shoots using IBA. While different concentrations of IBA were examined, 500 ppm (2.46 mM) was found to be most effective. The lower concentration (0.25 mM) of auxins (IBA and NAA) has also been reported to be effective in inducing rooting in *Taxus baccata* cuttings[11] during the monsoon season. IBA (100 & 500 ppm) has also been reported to be effective as a root promoting substance in *Quercus glauca*[12] and *Q. serrata*[13] through air layering of mature shoots. In general, auxin promotes rooting at lower concentration but inhibits at higher concentration; the optimum concentration of auxin required for rooting of stem cuttings seem to depend on the plant species, stock plant environment, the type of auxin used and the method of application[14, 15]. Auxins have also been shown to stimulate cambial activity resulting in the mobilization of reserve food towards the site of root initiation[16]. IBA is known to be a very effective rooting agent for many difficult-to-root species[17, 18] and is well recommended for general use because it is nontoxic to plants over a wide concentration range[18]. In the

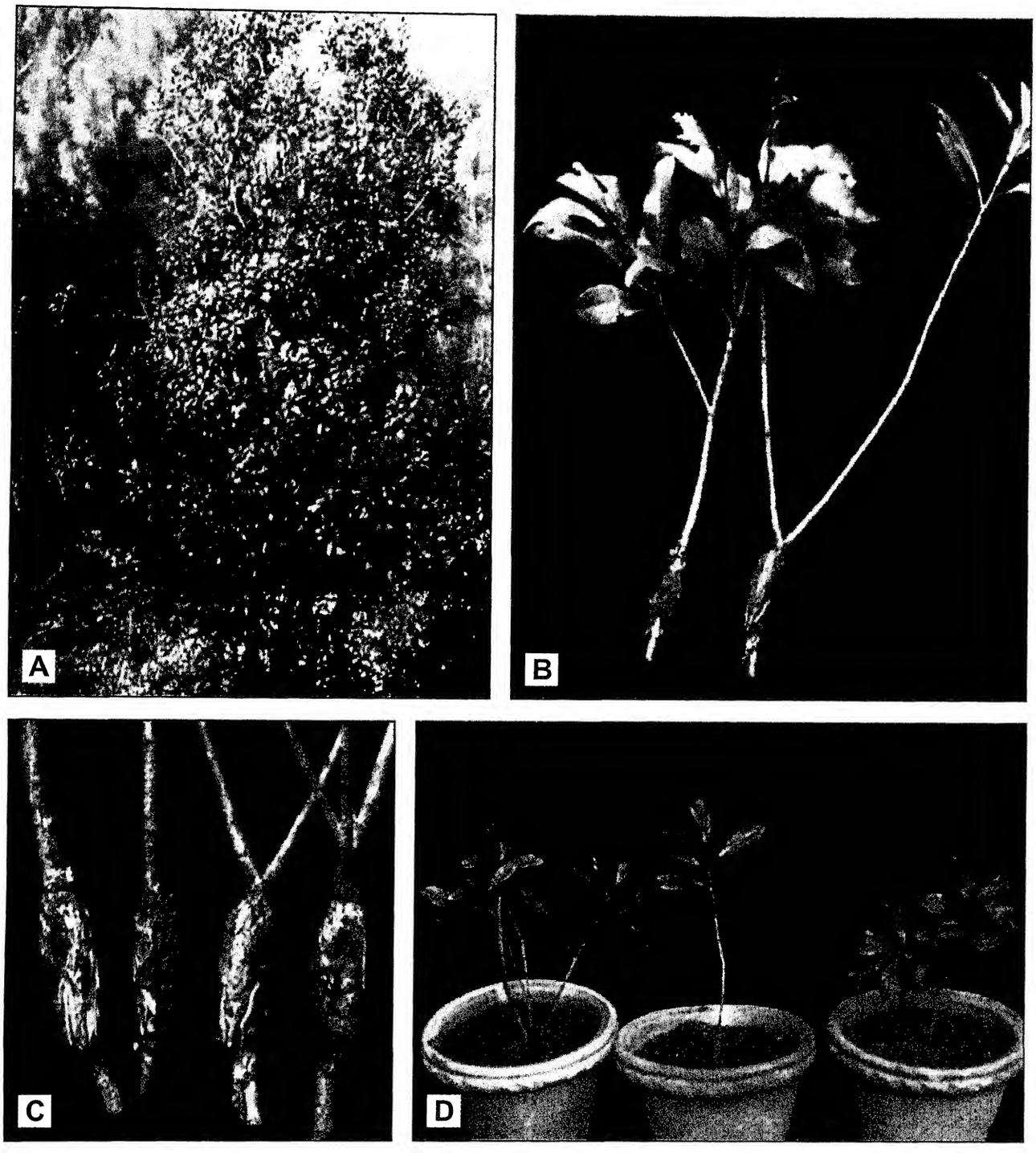

Fig. 1- Successful air layering in *Myrica esculenta:* (A) A mature tree growing in the forest (bar = 0.3 m), (B) Rooting of air layered shoots (bar = 4.0 cm), (C) A closer view of root formation (bar = 2.5 cm), and (D) Air layered plants 4 weeks after transfer to earthen pots.

present study air layering was carried out in the monsoon season to take advantage of (i) active growth season, and (ii) high humidity (about 90%) which has been reported to favour rooting of cuttings[14]. Successful air layering has also been reported in *Dalbergia sissoo*, *Grewia optiva*, *Ficus carica*[19], *Azadirachta indica*[20], *Eliocarpu sganitrus*[21], *Quercus glauca*[12], *Q. serrata*[13] and *Gossypium* species[22] with auxin treatments. Although Bavistin, possessing auxin like activity, was highly effective in stimulating root formation in cuttings of *T. baccata*[11] and *Cedrus deodara*[23], it was not effective in this investigation.

The results of this study are important and the reported low natural regeneration via seeds can be supplemented with clonally propagated plants raised through air layering. Further, well established plants could be obtained within a short time; the method is also inexpensive and easy to perform. It is hoped that it will be acceptable to the villagers and those involved in the forestry sector.

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Determination of some carbamate insecticides with N-bromosuccinimide reagent

Renu Upadhyay AND I.C. Shukla*

Department of Chemistry University of Allahabad, Allahabad. - 211002 (India)

E-mail: upadhyayrenu@.rediffmail.com

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Abstract

A quick and convenient method has been developed for the milligram determination of some carbamate insecticides. The sample is allowed to react with a calculated excess of (0.02N) N-Bromosuccinimide (NBS) reagent in the presence of glacial acetic acid and HCI for 5-10 min. at room temperature (25°C -30°C). After the reaction is over, 5 ml of KI solution (10%) is added and the unreacted reagent is back titrated with 0.02N solution of sodium thiosulphate to starch endpoint. The method is applied for the determination of technical samples and formulations of Carbaryl, Propoxur, Methiocarb, Bendiocarb and Aldicarb. The results are with in error of ± 1.0%.

(Keywords : carbamate/insecticide/N-bromosuccinimide)

Introduction

Carbamate insecticides are compatible with most of the common insecticides. These are mainly used for the control of bitting and sucking insects in the cultivation of field crops, fruits, vegetable, vines, hopes, and oranamentals. Because of their insecticidal activity their determination has widely been studied.[1-11] In the present method, we describe a simple titrimetric method for the milligram determination of some carbamate insecticides e.g. Carbaryl, Propoxur, Methiocarb, Bendiocarb, Aldicarb, in technical form and in their formulation using NBS reagent in acidic medium.

Reagents and Solutions

N-Bromosuccinimide (0.02 N, CDH) : The reagent solution was prepared and standardised iodometrically, sodium thiosulphate (Merck) 0.02 N aqueous solut-ion was prepared and standardised by titrating against primary standard copper sulphate (Glaxo) 0.025 N, aqueous solution of potassium iodide (10%), starch, 4N HCI were also prepared. Glacial acetic (Merck) was used without any dilution.

Sample Solution : The sample solutions of technical form such as Carbaryl, Propoxur, Methiocarb, Bendiocarb and Aldicarb, were prepared by dissolving accurately weighed (100 g.) sample in minimum amount of glacial acetic acid in 100 ml volumetric flask and then diluted up to full volume with distilled water. The sample solution of formulations were also prepared similarly.

Procedure : An aliquot containing 1-5 mg of the sample was taken in a 100 ml Erlenmeyer flask followed by the addition of 5 ml of NBS (0.02), 10 ml glacial acetic acid and 5 ml of 4N HCl. The flask was stoppered and the contents were allowed to react at room temperature (25°C-30°C) for prescribed reaction time. After the reaction is over 5 ml of 10% potassium iodide was added to it and titrated against standardised sodium thiosulphate solution (0.02N) to starch end point. A blank experiment was also run under identical conditions using all the reagents except the sample. The amount of the sample was calculated by the following expression.

$$\text{mg of the sample} = \frac{MN(B\text{-}S)}{n}$$

Where, M is Molecular weight of the sample, N is Normality of sodium thiosulphate solution, B is Volume of sodium thiosulphate solution for blank, S is Volume of sodium thiosulphate solution for the sample, n is number of moles of NBS consumed per mole of the sample.

Results and Discussion

The reaction conditions were established after studying the effect of variables such as reaction time, concentration and amount of the reagent and reaction temperature. Variation in reaction time was found to influence the speed of the reaction. Carbaryl require 5 min. and Propoxur, Methiocarb, Bendicarb and Aldicarb require 10 min. to the complete reaction. A lesser reaction time gives higher percentage error because of incomplete reaction. While a much more reaction time has no effect on the recovery of sample. It was established that the prescribed concentration of reagent, (0.02N) was suitable for accurate results. If a lower concentration of the reagent is used then the volume of reagent has to be increased and the reaction time is prolonged. Similarly a larger concentration is wastage of the reagent and gives no improvement in percentage recovery. It may also be mentioned that the reagent is susceptible to decomposition at higher temperature giving inaccurate result. If the reaction is carried out at ice-cold temperature the reactivity is retarded to a great extent. Results (Table 1) show that the present method is reproducible and can be adopted conveniently in an ordinary laboratory. On the basis of molecularity available literature[11-14] and the nature of the compound a possible course of reaction may be suggested for each compound. In the series of carbamate insecticides, Carbaryl (1-Napthyl-N-methyl carbamate) require 5 min. and consume 2 moles of NBS reagent. Here NBS reagent works as brominating agent and gives bibromosubst. carbaryl.

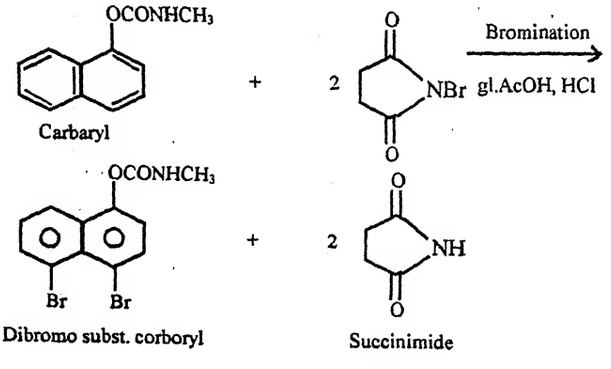


Table 1– Determination of some carbamate insecticides in technical preparations and formulation with N-bromosuccinimide in acidic medium.

Sample	Aliquots taken (ml)	Amount present (mg)	Reaction time (min.)	Mole-cularity	Amount obtained calcn*(mg)	Error (%)	SD (mg)	CV (%)
Carbaryl Tech (92%)	1.0	0.92	5	2	0.9112	-0.95	0.0016	0.0170
	3.0	2.76			2.7390	-0.73	0.0036	0.0127
	5.0	4.60			4.5789	-0.46	0.0081	0.0171
W.P.50%	1.0	0.50	5	2	0.4952	-0.96	0.0020	0.0404
	3.0	1.50			1.4888	-0.77	0.0051	0.0343
	5.0	2.50			2.4890	-0.48	0.0080	0.0321
W.P.20%	1.0	0.20	5	2	0.2478	- 0.88	0.0025	0.1009
	3.0	0.60			0.7442	-0.77	0.0045	0.0605
	5.0	1.00			1.2444	-0.45	0.0078	0.0627
Propoxur Tech(95%)	1.0	0.95	10	1	0.8914	-0.95	0.0035	0.0393
	3.0	2.85			2.6788	-0.78	0.0085	0.0617
	5.0	4.75			4.4778	-0.48	0.0131	0.0293
E.C. 50%	1.0	0.50	10	1	0.4950	-0.96	0.0010	0.0505
	3.0	1.50,			1.4891	-0.73	0.0041	0.0273
	5.0	2.50			2.4865	-0.54	0.0080	0.0320
W.P.20%	1.0	0.25	10	1	0.2476	-0.95	0.0025	0.1000
	3.0	0.75			0.7442	-0.77	0.0092	0.1226
	5.0	1.25			1.2430	-0.56	0.0182	0.1213
Methicarb Tech(80%)	1.0	0.80	10	1	0.7928	-0.90	0.0016	0.0200
	3.0	2.40			2.3822	-0.74	0.0031	0.0129
	5.0	4.80			4.7722	-0.58	0.0050	0.0104
W.P.20%	1.0	0.50	10	1	0.4960	-0.90	0.0020	0.0400
	3.0	1.50			1.4900	-0.75	0.0076	0.0507
	5.0	2.50			2.4850	-0.60	0.0110	0.0440

Contd... Table 1

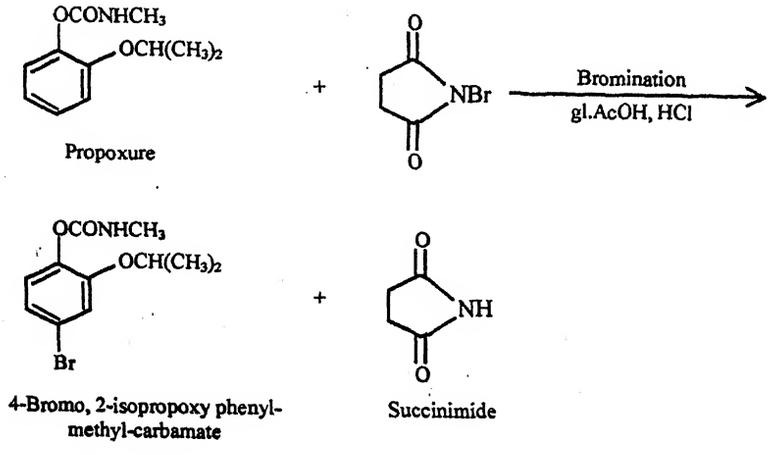
Contd... Table 1

Bendicarb Tech(82%)	1.0	0.82	10	1	0.8127	-0.89	0.0020	0.0243
	3.0	2.46			2.4408	-0.78	0.0050	0.0203
	5.0	4.10			4.0836	-0.40	0.0076	0.1854
W.P. 20%	1.0	0.20	10	1	0.1982	-0.91	0.0012	0.0600
	3.0	0.60			0.5157	-0.71	0.0017	0.0283
	5.0	1.00			0.9958	-0.42	0.0020	0.0200
Aldicarb Tech(86%)	1.0	0.86	10	1	0.8520	-0.93	0.0012	0.0139
	3.0	2.58			2.5619	-0.70	0.0018	0.0069
	5.0	4.30			4.2811	-.044	0.0021	0.0048
E.C. 40%	1.0	0.40	10	1	0.3963	-0.92	0.0016	0.0400
	3.0	1.20			1.1140	-0.72	0.0020	0.0167
	5.0	2.00			1.9920	-0.45	0.0012	0.0060

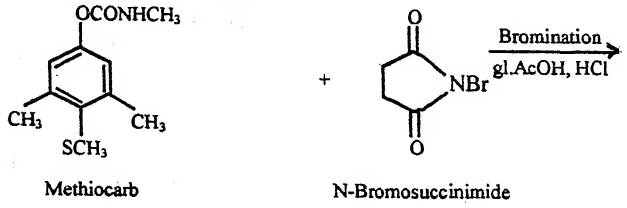
* Average of nine determinations.

The propoxur (2-isopropoxy phenyl methyl carbamate) consume one mole of NBS and is converted to the corresponding brominated product.

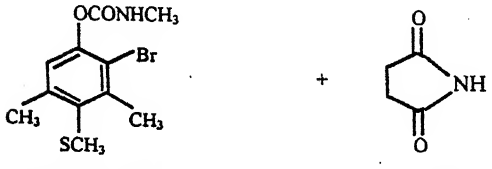
In case of methiocarb (4 methyl thio-3,5, xylyl methyl carbamate) consume one molecule of NBS and gets converted to the corresponding brominated product.



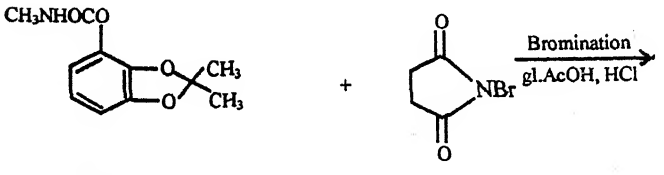
In the series of carbamate, Bendicarb (2,3-isopropylidenedioxy phenyl methyl carbonate) also consumes a mole of NBS and gets brominated.



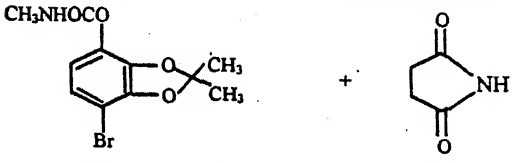
Methiocarb N-Bromosuccinimide



Bromo, Subst. methicarb Succinimide



Bendicarb N-Bromasuccinimide



Bromo, Subst.Bendicarb Bromasuccinimide

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Genesis of pandemic arsenic pollution affecting Bengal Basin

S. K. Acharyya AND B. A. Shah

Department of Geological Sciences, Jadavpur University, Kolkata 700032, India

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Abstract

The early Pleistocene sediments in the Bengal Basin were exposed and oxidized due to sea level draw down. Sea level rose during the late Pleistocene-early Holocene filling entrenched channels with gravel and sand. Both these sediment packets are generally free of arsenic problem. Arsenic contamination in groundwater in the Bengal Basin is essentially confined to the early-mid Holocene deltaic sediments. Deltaic setting was induced by rapid rise of sea level around 10,000-7500 yr. ago. Discrete phases of Fe-Mn-oxyhydroxide with sorbed arsenic, derived both from the Himalayas and the Peninsular India, were preferentially entrapped in organic rich deltaic sediments. Biomediated reductive dissolution of Fe-Mn-oxyhydroxide and corresponding oxidation of sedimentary organic matter later released sorbed arsenic to groundwater. Recent excessive extraction of groundwater has enhanced recharge rate in shallow aquifers. Movement of groundwater enriched in degraded organic matter through FeOOH coated sediments triggered reduction process and released sorbed arsenic. Arsenic concentration in groundwater varies at random due to multi parametric boundary conditions controlling biomediated reactions.

(Keywords : arsenic in groundwater / Bengal Basin / Ganga delta sedimentation /Holocene sea level changes).

Introduction

Pandemic arsenic pollution affects large tracts of West Bengal (India) and Bangladesh. Concentration of arsenic in groundwater exceeds 0.05 mg/l (permissible limit for drinking water in India and Bangladesh, whereas WHO recommendation < 0.01 mg/l) and arsenic related diseases are recorded from 9 out of total of 18 districts in West Bengal[1], and 61 districts out of its total of 64 in Bangladesh[2] (Fig. 1). It is an irony that arsenic malady in this belt was recognized after incurring huge expenditure for switching to groundwater for irrigation and drinking purposes, which was primarily responsible for attaining food self-sufficiency and reduction in infant mortality. The release of arsenic to groundwater in the Bengal Basin is a natural phenomenon but appears to have been triggered by recent practice of excessive extraction of groundwater.

Sedimentation During Holocene Sea Level Fluctuation

The lowland alluvial basin of the rivers Ganga, Jamuna and the old Brahmaputra were entrenched and incised during the low sea level setting of the early Pleistocene

period. The Pleistocene uplands flanked the western side of the Bengal Basin in West Bengal (India), and those at Barind and Madhupur areas marked the northern and central parts of the basin in Bangladesh (Fig. 1). Sediment cover on these uplands was oxidized, well flushed by groundwater and are free of arsenic problem. The gravel and sand beds, comprising the basal late Pleistocene-early Holocene channel fills of proto-Ganga-Brahmaputra and Bhagirathi rivers are also free of arsenic problem.

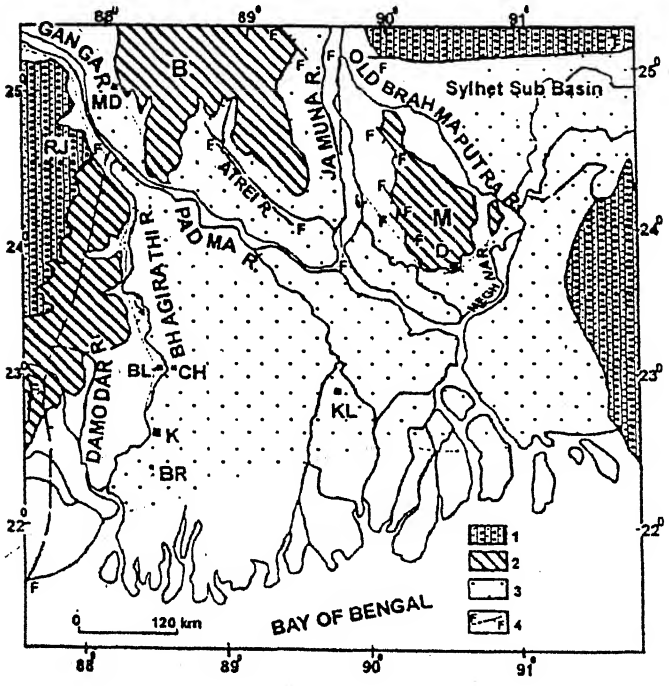

Fig. 1– Map of a part of the Bengal Basin. 1-Hills of older rocks, 2-Laterite and Older Alluvial uplands, 3-Arsenic affected Younger Delta Plain (includes uplifted sediments of the Tippera surface flanking the Tertiary hill in the East). Uplands : B-Barind, M-Madhupur, RJ-Rajmahal hills. Localities : BL-Balagarh, BR-Baruipur, CH-Chakdah, D-Dhaka, K-Kolkata, KL-Khulna, MD-Malda.

Arsenic contamination essentially affects low-lying Ganga delta area down stream of the Rajmahal Hills and other low-lying areas (Fig. 1). Delta sedimentation was induced over large area during 10,000 yr. to 7500 yr. ago, when rapid rise of sea level back-flooded and over-topped the entrenched channels and oxidized early Pleistocene surfaces[3]. Continued high sea level setting during most of the early-mid Holocene period, flooded partly sedimented entrenched valley courses and converted their lower and adjacent parts to fluvial marshes, lagoons and estuary. High sediment load from the rapidly eroding Himalayas competed with rapid sea level rise to enforce sluggish deltaic sedimentation dominated by fine grained often dirty sand with mud and silt. The lenticular muddy sand bodies generally formed numerous transient distributory channels[3]. Most arsenic contaminated tubewells mainly tap aquifers in this unit, which is very poorly flushed by groundwater due to their deltaic setting under high sea level condition and very poor hydraulic gradient. Thus any arsenic released from these sediments following burial accumulated in groundwater.

The top mud facies were deposited throughout the Bengal Basin during rapid sea level rise since 7,000 yr. ago, when sea level reached higher than the present level and the southern parts of the Ganga delta were invaded by tidal mangrove and encroached by the Bay of Bengal. After the post-glacial optimum, the sea level dropped initiating a phase of subdued marine regression. There was extensive development of marine and fresh water peat during 7,000 to 2,000 yr. ago.

Source of Arsenic

Potential sources of arsenic in the form of polymetallic sulphides, abundant biotite/chlorite, magnetite and other ferromag-

nesian minerals, occur both in the Himalayas and the Peninsular India. Contrary to claim other wise, our mineralogical studies establish that arsenic rich pyrite or separate arsenic minerals are rare or absent in the aquifers from affected areas in West Bengal[3-4]. However, rare presence of biogenic pyrite is recorded in reducing environment often in association of degraded plant remains[5-7]. These have acted as sinks for and not sources of arsenic. Studies on drill cores of aquifer sediments from arsenic polluted and safe zones located within the overall arsenic affected Chakdah and Baruipur blocks in Nadia and South 24-Parganas districts, in southern West Bengal (Fig. 1) reveal common occurrence of iron-coated quartz and clay (illite) grains, Fe-Mn-siderite. magnetite and biotite/chlorite, which are arsenic bearing[5-6]. Sludge samples are studied from Balagarh block, Hoogly district, which is one of the few arsenic affected area that is located to the west of the river Bhagirathi and has Peninsular India as its exclusive provenance[7] (Fig. 1). Very coarse sands at 100-150 m depth in this area possibly belong to the proto-Damodar river fan. These contain minor fractions of peaty wood fragments within which arsenic is locked in authigenic and framboidal pyrite. Some of this pyrite replaces woody cellular structure and some are arsenic bearing (Fig. 2). A few sediment grains also contain colony like aggregates of Fe-Mn-siderite concretions that are associated with framboidal pyrite. Similar colony like concretionary growth of siderite and framboidal pyrite is also recorded from Chakdah block[6]. Arsenic concentration in aquifer sediments is at moderate and comparable level from adjacently located arsenic polluted and safe areas[5-6].

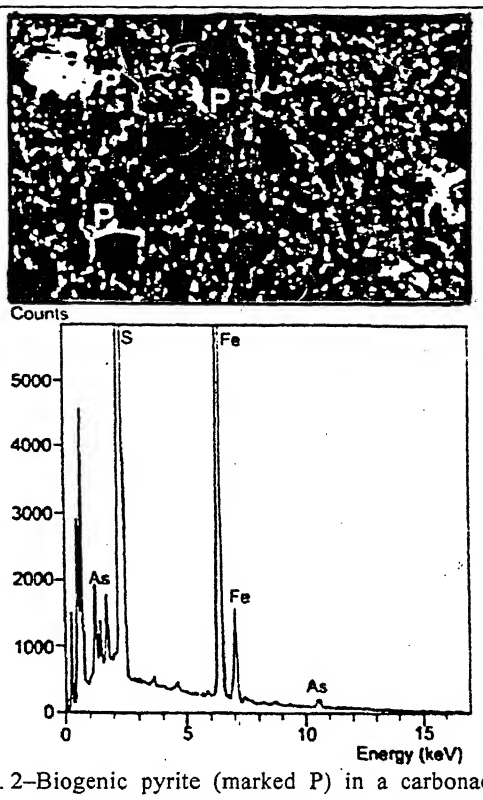

Fig. 2–Biogenic pyrite (marked P) in a carbonaceous shale clast. Pyrite growth often follows grain boundary. Arsenic-bearing nature of pyrite revealed by SEM-EDX scan, Balagarh-Sripur area, Balagarh.

Mobilization of Arsenic to Groundwater

Release of arsenic by oxidation of pyrite[8-9] is disproved, because pyrite or other mineral phases of arsenic are absent or rare in the affected aquifer sediments and sulphate concentration is also very low in contaminated groundwater. Biomediated reductive dissolution of iron oxyhydroxide (FeOOH) that occurs mainly as coating on sediment grains and corresponding oxidation of sedimentary organic matter is regarded as the main mechanism mobilizing arsenic to groundwater[10-12]. Released ferrous ion possibly combines with abundantly present bicarbonate in groundwater to form siderite concretions around sediment grains and/or centers of such Fe-reducing bacterial colony. Reduction of FeOOH is common and intense in the Bengal Basin as shown by a maximum

level of dissolved Fe concentration (≤ 9-36 mg/l) in arsenic contaminated groundwater[3-5]. Under stronger reducing condition and in the presence of organic carbon, sulphate-reducing bacteria (SRB), precipitates pyrite, which sorbes arsenic from groundwater. Inferred biomediated chemical reaction-cycle mobilizing arsenic to groundwater may be as follows: $4F^{3+}OOH + CH_2O$ (Organic matter) + $7H^+ = 4Fe^{2+} + HCO_3^- + 6H_2O$; $Fe^{2+} + HCO_3^- = FeCO_3$ (Siderite) + H^+; $2CH_2O + SO_4^{2-} - 2HCO_3^- + H_2S$ (Sulphate reduction); $Fe^{2+} + 2H_2S = FeS_2 + 4H^+$ (Authigenic pyrite precipitation, which sorbs co-precipitated arsenic from groundwater).

The presence of tritium, high C^{14} (~80-112 pMC) and δO^{18} values (-3.5 to -5.5%) in shallow aquifer groundwater in the Bengal Basin[13-14] indicates continuing recharge from local rain, surface and floodwater. Extensive groundwater extraction has enhanced flow of groundwater that brought dissolved degraded organic matter in contact with FeOOH bearing sediments enhancing reduction process and triggering release of arsenic[5]. Arsenic contamination in groundwater in alluvial aquifer is typically confined to organic rich fluvio-deltaic sediments e.g. Ganga-Brahamaputra delta in the Bengal Basin[4,9-10], Red and Mekong River deltas in Vietnam[15]. Major parts of the Ganga Alluvial Plain mainly exposing older alluvium is however, free of arsenic pollution although this fertile area is also subjected to equally intensive groundwater irrigation. The enrichment of arsenic is likely to be low in relatively coarser alluvium in the Ganga Alluvial Plains from the States of Bihar and Uttar Pradesh due to inputs from the Himalayan rivers. Dissolved iron content in groundwater from the Ganga Plain mainly exposing older alluvium is generally low (< 1 mg/l)[3-4], thus the environment is not sufficiently reducing to release iron and arsenic to groundwater. Aquifers in Bangladesh are regarded by some[16] to be inadequately rich in organic matter to cause severe reduction necessary for intense arsenic pollution, but may account for pervasive low-level contamination. They ascribe intense arsenic pollution in Bangladesh to be caused by biodegradation of buried peat. The peat beds in the Bengal Basin, however, are mainly restricted to southern-most part of the basin and in the top clayey sequence. Contrary to claim otherwise, the area and depth of peat beds does not correlate well with distribution of arsenic polluted area and thus biodegradation of buried peat beds might have played a minor roles. Severe As pollution in moderately reducing groundwater has been reported recently from Semaria Ojha Patti, Bihar[9], located within a narrow entrenched flood-plain located over 300 km upstream from the Rajmahal Hills. Such local conditions are not representative of the Ganga Alluvial Plain. It is scientifically unrealistic to predict from such local occurrences[17] that "groundwater will be arsenic contaminated" widely over the Ganga Alluvial Plain[9].

Conclusions

Sedimentation in the Bengal Basin is strongly influenced by sea level fluctuation and tectonism, which has controlled the distribution of arsenic polluted areas in the basin. Arsenic concentrations in aquifer sediments are however, moderate and broadly comparable in arsenic polluted and safe zones from West Bengal. Discrete phases of Fe-Mn-oxyhydroxide with sorbed arsenic, occurring mainly as coating on sediment grains were preferentially entrapped within early-mid Holocene organic rich deltaic sediments. Biomediated

reductive dissolution of iron oxyhydroxide (FeOOH) and corresponding oxidation of sedimentary organic matter from these deltaic alluvium represent the main operative process resulting release of sorbed load of arsenic to groundwater. Pyrite is generally absent or very rare, and where present occurs as authigenic and framboidal form and within degraded organic matter under reducing condition. At times it occurs in association with biogenic colony like aggregate of Fe-Mn-siderite concretions. Arsenic is mobilized to groundwater along with release of ferrous ion by iron-reducing bacteria (IRB) preferably from Fe-oxyhydroxide coatings on sediment grains or from Fe-bearing mineral phases. Ferrous ion apparently reacted with abundantly present bicarbonate in groundwater to form siderite concretions around mineral grains and or colonies of Fe-reducing bacteria (IRB).

Extensive extraction of groundwater enhanced recharge rate of shallow aquifers. Movement of groundwater enriched in degraded organic matter derived either from the sediments and/or supplemented by those infiltrating from irrigated fields through FeOOH coated sediments triggered dissolution of FeOOH and release of sorbed arsenic to groundwater.

Acknowledgements

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Estimation of the internuclear distance in some diatomic molecules, viz. SrCl, CaBr, MgI, BiF, AsCl, SbCl, LiRb and SbS

V. G. Asolkar[#] AND C. Mande

Department of Physics, Nagpur University, Nagpur - 440033, India.

[#]L. A. D. College for Women, Nagpur - 440010, India.

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Abstract

The values of internuclear distance r_e in some diatomic molecules, *viz.* SrCl, CaBr, MgI, BiF, AsCl, SbCl, LiRb and SbS which are not reported in literature have been estimated from the consideration of rotational constants following the method given by us earlier.

(Keywords : internuclear distance/rotational constants/ electronegativity)

Introduction

The knowledge of the value of the equilibrium internuclear distance r_e in a diatomic molecule is of considerable importance since it is related to many of its physicochemical properties. The data on r_e have been reported for a large number of molecules but a survey of literature reveals that the values of r_e in some diatomic molecules are not yet reported. In previous publications[1,2,3] the authors have reported the values of r_e for certain molecules. In the present communication, we are reporting the values of r_e in some more molecules, *viz.* SrCl, CaBr, MgI, BiF, AsCl, SbCl, LiRb and SbS for which the values on r_e are not cited in literature[4,5].

Estimation of the values of r_e from rotational constants

In our earlier publications[1,6,7], we have shown that the data on the rotational constant B_e of diatomic molecules can be systematized with electronegativity. We have, for the first time established the following three relations

$$\log B_e = m \log\left(\frac{\Delta\chi}{\mu^2}\right) + C \qquad (1)$$

$$\log B_e = m \log\left(\frac{\sqrt{\chi_A \chi_B}}{\mu^2}\right) + C \qquad (2)$$

and

$$\log B_e = m \log\left(\frac{\chi}{\mu^2}\right) + C \qquad (3)$$

where χ_A and χ_B are the electronegativity values of the atoms A and B and $\Delta\chi$ is the electronegativity difference. The values of electronegativity were taken from the scale of Mande and coworkers,[8,9] which is based on the effective nuclear charges obtained from X-ray spectroscopic data. According to

Mullay[10], this scale is more reliable and also is in good correlation with Pauling's scale. It has been shown that the diatomic molecules of the type AB with predominant ionic character in the bonding get systematized with the help of equation (1), whereas those with predominant covalent character get systematized with equation (2). Equation (3) is applicable to homopolar diatomic molecules of the type AA and is just a special case of equation (2). These equations have helped us to estimate the values of B_e in diatomic molecules[1,2,3] for which such data were not reported in literature. The. values of r_e can be determined from these values of B_e by using the expression[11].

$$B_e = \frac{h}{8\pi^2 c\mu r_e^2}. \qquad (4)$$

In the present work, we have estimated the values of B_e in SrCl, CaBr and MgI from the plot of log B_e *vs.* $\log\frac{\Delta\chi}{\mu^2}$ for IIA halides, and in BiF, AsCl and SbCl from a similar plot for VA halides. The value of B_e for LiRb is estimated from the plot of log $\frac{\sqrt{\chi_A\chi_B}}{\mu^2}$ *vs.* log B_e for IA homopolar and intragroup heteropolar diatomic molecules and for SbS from a similar plot for VA oxides and chalcogenides.

We observe from the plot for IIA halides (Fig. 1) that although for most of the molecules, we obtain a good straight line with m = 0.66, C = 0.68 and R^2 = 0.9829, the points for beryllium halides do not lie on this straight line. These points seem to lie on a separate straight line with m = 0.58 and C = 0.87 as shown in this figure. This may appear surprising but it may be justified by considering the small size and lightness of the beryllium atom as compared to the rest of the group IIA atoms, which render these molecules much more ionic. It has been shown that the molecule BeF is highly polar[12] as compared to the other halide CaCl[12,13] of the same group. This kind of bonding nature in

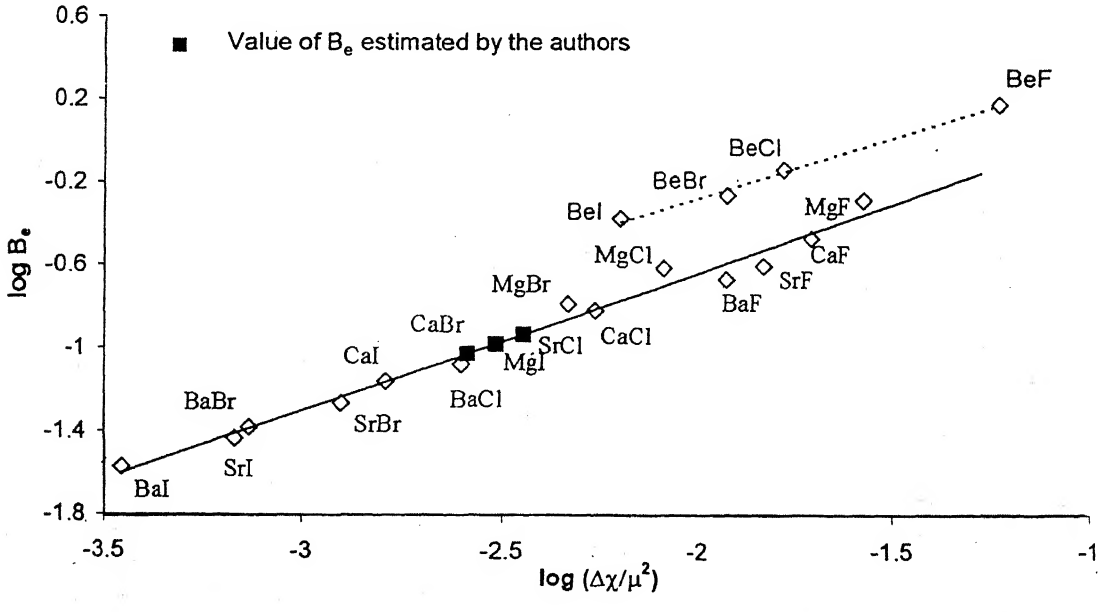

Fig. 1– Variation of the values of log ($\Delta\chi/\mu^2$) against those of log B_e for IIA halides.

beryllium halides may be responsible for the systematization of these molecules with a separate straight line as compared to the rest of the IIA halides.

From the main line in Fig. 1 we have estimated the values of B_e for SrCl, CaBr and MgI and they come out to be 0.1164 cm^{-1}, 0.0939 cm^{-1} and 0.1047 cm^{-1} respectively. From these values of B_e, the values of r_e calculated by using equation (4) come out to be 2.4060 A°, 2.6014 A° and 2.8252 A° respectively.

Similarly Fig. 2 shows two separate plots for the VA halides, when the values of log B_e are plotted against the log $\frac{\Delta\chi}{\mu^2}$ values. The occurrence of the two lines for the VA halides can be explained on the similar grounds as those of the plots for IIA halides. From the main line with m = 0.62, C = 0.83 and R^2 = 0.9651 we have estimated the values of B_e for BiF, AsCl and SbCl which come out to be 0.3485 cm^{-1}, 0.1013 cm^{-1} and 0.1238 cm^{-1} respectively. From these values of B_e, the values of r_e for these molecules come out to be 1.6666 A°, 2.6420 A°, and 2.2406 A° for BiF, AsCl and SbCl respectively.

Fig. 3 shows a plot between log $\frac{\sqrt{\chi_A\chi_B}}{\mu^2}$ *vs.* log B_e for IA homopolar and intragroup heteropolar diatomic molecules. The values of m, C and R^2 for this plot are 0.64, 0.53 and 0.997. From this plot, the value of B_e for LiRb is estimated to be 0.2668 cm^{-1} which gives the value of r_e to be 3.1224 A°.

From Fig. 4, which is a plot between log $\frac{\sqrt{\chi_A\chi_B}}{\mu^2}$ *vs.* log B_e for VA oxides and chalcogenides with m = 0.87, C = 1.21 and R^2 = 0.9872, we have estimated the value of B_e for SbS. It comes out to be 0.1188 cm^{-1}. From this value of B_e, the value of r_e comes out to be 2.3689 A°.

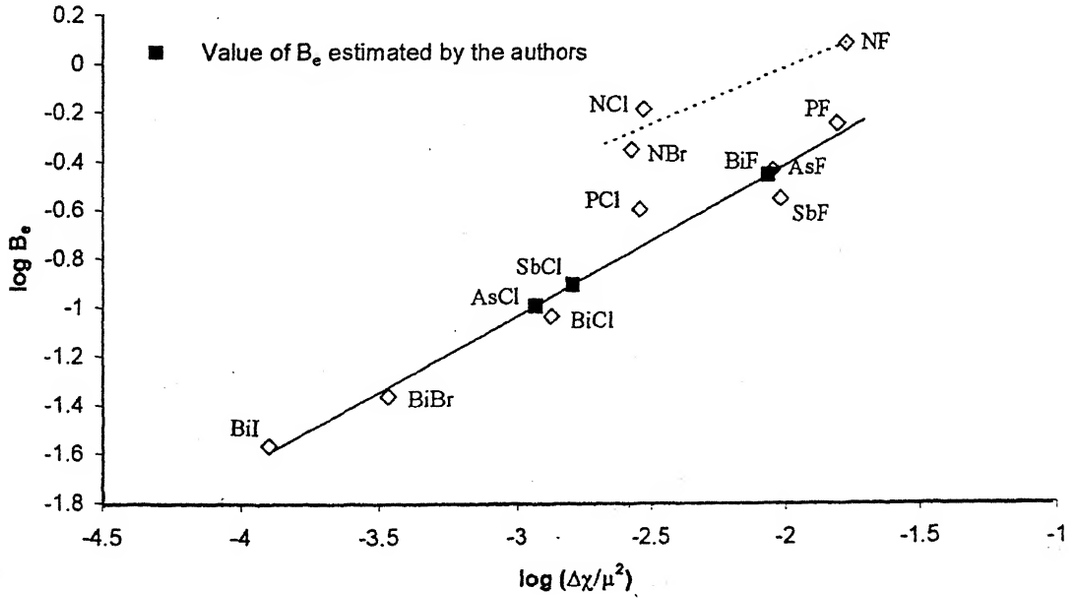

Fig 2– Variation of the values of log ($\Delta\chi/\mu^2$) against those of log B_e for VA halides.

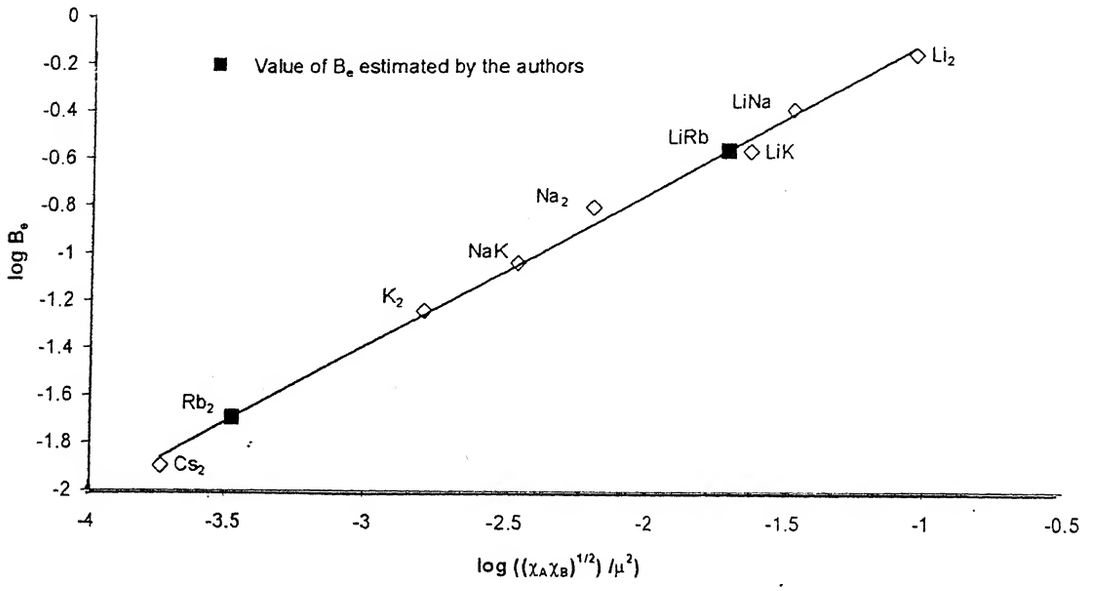

Fig 3– Variation of the values of log $((\Delta\chi_A\chi_B)^{1/2})/\mu^2)$ against those of log B_e for IA intragroup heteropolar and homopolar diatomic molecules.

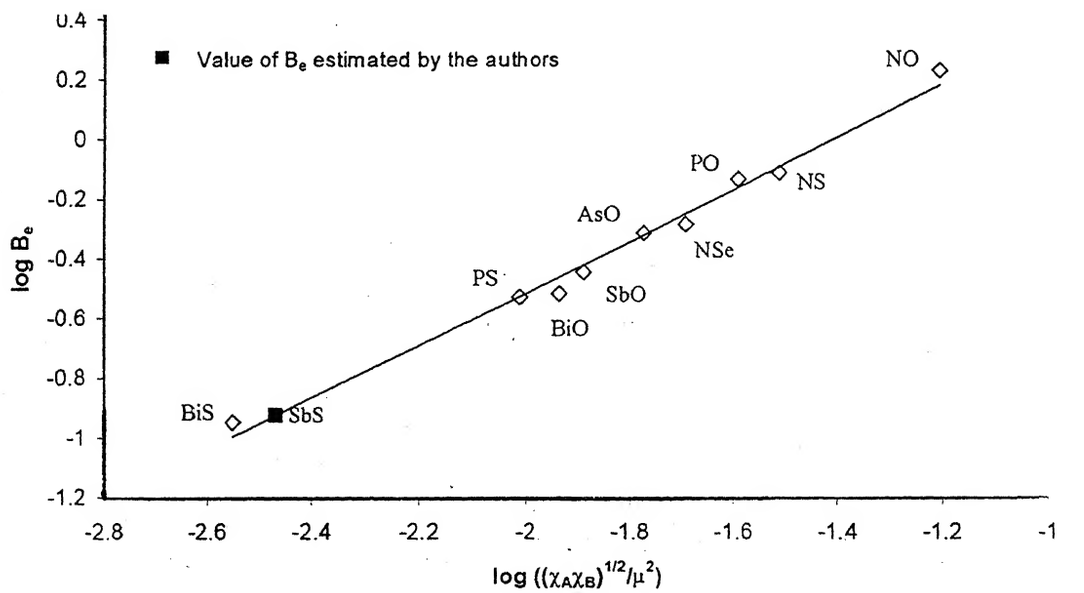

Fig 4– Variation of values of log $((\Delta\chi_A\chi_B)^{1/2})/\mu^2)$ against those of log B_e for VA oxides and chalcogenides.

It is felt that the resolution of the plots in Fig. (1 and 2) has helped us in obtaining more reliable values of B_e in the molecules SrCl, CaBr and MgI, and BiF, AsCl and SbCl, and in turn their r_e values.

Considering the nature of data used for these estimations, we have given in column 3 of Table 1 the values of r_e rounded off to two places after the decimal point. We may mention, here that this much accuracy is generally sufficient for most of the work in physics and chemistry. We hope that these data may be useful to experimental workers. Our work brings out the use-fulness of the concept of electronegativity in studying molecular structure.

Table 1– The values of internuclear distance r_e obtained from rotational constants.

Molecule	B_e (cm^{-1})	r_e (A°) from B_e
SrCl	0.1164	2.41
CaBr	0.0939	2.60
MgI	0.1047	2.83
BiF	0.3485	1.67
AsCl	0.1013	2.64
SbCl	0.1238	2.24
LiRb	0.2668	3.12
SbS	0.1188	2.37

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THE NATIONAL ACADEMY OF SCIENCES, INDIA

SEVENTY-FOURTH ANNUAL SESSION

Dr. V.P. Kamboj
Ph.D.,D.Sc.,F.N.A.,F.N.A.Sc.
Prof. Pramod Tandon
Ph.D.,F.N.A.Sc.
General Secretaries

5, Lajpatrai Road,
Allahabad – 211 002

21.4.2004

Dear Sir/Madam,

We are happy to inform you that the 74th Annual Session of the Academy will be held from December 2-4, 2004 at Jaipur under the auspices of University of Rajasthan, Jaipur.

On behalf of The National Academy of Sciences, India, we have great pleasure in inviting you to attend the Session and participate in the deliberations.

Scientific Sessions

The Scientific Sessions will be held in two sections : Section of Physical Sciences and Section of Biological Sciences. The Physical Sciences Section will be presided over by Prof. Ashok Misra, Director, Indian Institute of Technology, Powai, Mumbai – 400 076, and Biological Sciences Section will be presided over by Dr. Amit Ghosh, Director, Institute of Microbial Technology, Sector 39-A, Chandigarh – 160 036.

The National Academy of Sciences India - Swarna Jayanti Puruskar each comprising Rs.5000/= and citation will be given to the young scientists presenting the best research paper in the Sections of Physical and Biological Sciences.

Symposium

A National Symposium on **"Science & Technology for Desert Development"** will be held during the Annual Session. **Presentation of papers in the Symposium would only be through invitation.**

All interested persons are invited to attend the Scientific Sessions of the Symposium and Sessions of Physical and Biological Sciences; however, other facilities will be available only to those who get themselves registered with the host institution.

Sessional Membership

Fellows and Members are entitled and most cordially invited to attend the Sessions and the Symposium. Scientists, stipendiary research scholars and others **who are not Fellows or Members of the Academy** but are interested in attending the Session and may like to present papers are required to enroll themselves as Sessional Members on payment of Rs.50/= only. They would be entitled to all privileges of Academy Members during the Session.

Non-stipendiary research scholars and students can enroll as Sessional Members on payment of a concessional amount of Rs.30/= only. The Sessional Membership is valid only for the Session.

The Sessional membership fee may be sent to the Executive Secretary, The National Academy of Sciences, India by a Bank Draft or an Indian Postal Order or Account Payee Local Cheque drawn in favour of **'The National Academy of Sciences, India'.**

Payment in Cash/Money Order/Outstation Cheque will not be accepted.

Privileges

Regular Members of the Academy and Sessional Members are entitled to attend the Session, submit papers for presentation, receive copies of Presidential Addresses, Abstracts of papers and other papers circulated during the Session and participate in other activities. They will be entitled to travel at concessional rates as per Rules*. All papers submitted for presentation (Oral and Poster) will be screened. Authors whose papers are found fit for presentation would be informed at the earliest.

The Academy would pay, on production of Xerox copy of Railway tickets, second-class rail fare, by shortest route (both ways) only, to the author who would present the paper provided his/her travel has not been subsidized by any other agency. Authors whose papers have been found fit for presentation and desire payment of second-class fare may write to the Academy in advance.

Abstracts

Two copies of abstracts of papers (not exceeding 200 words and typed in duplicate), alongwith two copies of full length papers for presentation in the Scientific Sessions should reach the Office of the Academy at 5, Lajpatrai Road, Allahabad – 211 002 latest by August 31, 2004. An author can submit up to a maximum of three papers including papers having more than one authorship.

Paper Presentation

Both ORAL as well as POSTER presentation of papers will take place. Authors will be informed about the mode of presentation for which their papers have been selected.

* As per current rules, Scientists drawing total emoluments upto Rs.3,000/= per month are only entitled to receive a Railway concession. Those desiring to obtain Railway concession may write to the General Secretary referring the nature of their Membership.

Publication of Papers

In case it is desired that a paper presented at the Annual Session be considered for publication in the Proceedings of the National Academy of Sciences, India / National Academy Science Letters, it must be submitted **separately** in triplicate in the appropriate format **under separate cover** addressed to the Editor concerned. These papers will undergo the usual processing as per rules of the Academy. Papers sent for the Session will not be automatically considered for publication.

Registration

Registration of the Fellows, Members, and Sessional Members will be done by the host institution.

The host institution would inform you directly about the amount and date of receipt of Registration fee, facilities regarding accommodation for delegates etc. **Please do not send your Registration fee to the Academy Office at Allahabad.**

We once again extend a very cordial invitation to you to participate in the 74th Annual Session of the Academy at Jaipur.

Yours truly
V.P. Kamboj
Pramod Tandon

POSTER DISPLAY GUDELINES

1. Each participant in the Poster Session will be provided with a board, measuring approximately 3' x 4' at the venue of the Session for mounting the display – written matter, diagrams, photographs etc.

   The board will stand approximately at eye height viz. its top will be about 5' from the ground level.

2. Participants may ensure that written matter is bold enough and diagrams and photographs large enough to be clearly visible from a distance of 2-3 ft. (Suggested size of letters not less than 6 mm).

   A strip, about 2½" wide bearing Abstract No., brief title and name(s) of author(s) may be prepared to be put at the top of the board e.g.

   Abs. No. ..... Culture of Simocephalus vetulus ...' Malhotra *et.al.*

3. The authors will be informed of the date and time of their poster display on arrival. They will get about 1- 1½ hrs. to mount their posters on the board. It is, therefore, suggested that authors plan the lay out of displays on the board in advance.

   Adhesive materials will be provided.

1. **Group Discussion on Domination in Discrete Structures and Applications (GDDDSA 2004)** from November 15-24, 2004, organized by the Department of Mathematics, EMG Yadava Women's College, Madurai – 625 014, Tamil Nadu, India,

   Completed application routed through proper channel should reach the local coordinator on or before June 30, 2004.

   Contract :

   Prof. R. Poovazhaki
   Head, Department of Mathematics,
   EMG Yadava Women's College,
   Madurai – 625 014, Tamil Nadu, India
   E-mail : rpoovazhaki@yahoo.co.in
   Phone : Off : 0452-2681247 Cell : 98428-62749
   Res : 0452-2683108

2. **19th Annual Conference of the RAMANUJAN MATHEMATICAL SOCIETY,** from July 21-24, 2004, organized by the Department of Mathematics, Institute of Basic Science, Dr. B.R. Ambedkar (Agra) University, Khandari, AGRA – 282 002

   Contact :

   Prof. Sunder Lal
   E-mail : snder_lal2@rediffmail.com
   Phone : (O) 0562-2152129
   [M] (O) 9412259782

3. Applications for **BRSI Annual Awards Nomination-2003** are invited.

   For details contact to
   President, Biotech Research Society of India,
   Regional Research Laboratory, CSIR,
   Trivandrum – 695 019;
   Tel 0471-2515279/2495949;
   Fax 0471-2491712;
   E-mail : brsihq@yahoo.co.in

JOURNAL FORMAT AND GUIDELINES FOR THE AUTHORS/CONTRIBUTORS

[A] WHAT TO SUBMIT

All papers would pass through a strict "Peer review" to ensure high quality.

The National Academy Science Letters publishes articles under the following categories :

(i) ***Lead Articles/Overviews of new developments in Science and Technology*** from "recognized experts" to educate, initiate and provocate young scientists for undertaking research in innovative, challenging and cross – disciplinary new research areas. ALL EXPERTS ARE WELCOME TO CONTRIBUTE. These articles are not meant to be Bibliographic or complete literature reviews but are expected to give selected references and future/past trends. Articles may be of 3000 to 5000 words. Special "Academy Award Lectures" and "Presidential Addresses" etc. may occasionally be published under this category.

(ii) ***News/Views/Comments*** with an aim to bring out recent national/international scientific developments and controversial viewpoints. The number of words in such article should be less than 3000. Short Comments and author's rebuttal on articles published in this category are also welcome (max 500 words).

(iii) ***Science & Technology Development and Policy Issues*** with an aim to serve as Science-Society interface. Articles should be less than 2000 words.

(iv) ***Short Research Communications*** with an aim to publish *high quality* and break through *investigations*, which need immediate and rapid attention. Routine research work or data shall not be acceptable which may be submitted to the regular *Proceedings of the National Academy of Sciences, India* for consideration. The maximum number of words for these articles is 2000.

(v) ***Academy News/Announcements***

(vi) ***Forthcoming Meetings/Seminars/Conferences*** will serve as an avenue for informing a wide audience of professional scientists about the Meetings/Seminars etc. being organized by different organizations. This would include title and scope of the conference/organizer's address/important dates or deadlines. The maximum number of words is 100. All scientists/recognized professional organizations can submit such notifications.

(vii) ***Miscellaneous Special Issues.***

[B] HOW TO SUBMIT

(a) Manuscripts may be submitted to either of the following :-

(i) **Prof. Girjesh Govil** (Member, Board of Editors), Formerly Senior Professor, Tata Institute of Fundamental Research, Colaba, Mumbai – 400 005, **E-mail : govil@tifr.res.in**; Fax No. (022) 22804610, 22804611.

(ii) **Prof. Jai Pal Mittal** (Member, Board of Editors), Director, Chemistry and Isotope Group, Bhabha Atomic Research Centre, Trombay, Mumbai – 400 085, E-mail : **mittaljp@magnum.barc.ernet.in**; Fax No. (022) 25505151, 25519613

(iii) **Prof. Suresh Chandra** (Member, Board of Editors) Emeritus Scientist, Department of Physics, Banaras Hindu University, Varanasi – 221 005, E-mail : **schandra@banaras.ernet.in.**; Fax No. (0542) 2317040.

(iv) **Dr. M.S. Sinha**, Executive Secretary, The National Academy of Sciences, India, 5, Lajpatrai Road, Allahabad – 211 002, E-mail : **nasi@sancharnet.in;** Fax No. (0532) 2641183.

(v) **Dr. Niraj Kumar**, Assistant Executive Secretary, The National Academy of Sciences, India, 5, Lajpatrai Road, Allahabad – 211002, E-mail : **nasi@sancharnet.in**; Fax No. (0532) 2641183.

(b) Manuscripts should be typewritten in English, double-spaced and should be submitted in triplicate. All mathematical expressions should be typed or written clearly in black ink. For speedy publication, an electronic version in a "Floopy (3.5", IBM PC format only, not Macintosh)" is desirable. The text of the manuscript as per format of the Journal, and preferably with scanned figures, should be supplied as a plain ASC II file (WordStar 5.5 or 7.0 and Microsoft Word for Windows 6.0 are acceptable, but ASC II is preferred).

(c) The communication should contain a minimum number of tables, figures and photographs. Figures must be drawn in such a way that they can be reduced to one column width (7.5 c.m.). Figures must be original drawings or exceptionally sharp glossy prints of about manuscript size. The space occupied by the figures/tables/photographs will be at the expense of text "word-length" as specified above in [A]. Each Figure will be counted as 200 words, each short table as 150 words and full-page table as 300 words.

(d) All references should be indicated in the text by superscript Arabic numerals, e.g. 'Mirri[2] while working on .....' The list of references should be arranged in order of their occurrence in the text. Reference should be given in the following style :

2. Mirri, M.A. (1982) J. Chem. Phys, 58 : 282 (for articles in Journals).
Author Year Journal Vol. I beginning page
White, M.J.D. (1973) Animal Cytology and Evolution, 3rd Ed., Cambridge University Press, London, p. 320 (for Books)
Osgood, C.F. (1977) in Number Theory and Algebra, ed., Zassenhaus, H., Academic Press, New York, p. 321 (for edited Books).
Abbreviations of the names of periodicals should conform to those given in the World list of Scientific Periodicals.

(e) Keywords : A maximum of 5 keywords should be supplied. Each of these words will be separated by a slash (/) and printed just below the title of the research paper, e.g. (steroid receptors/protein-DNA interaction/gene regulation).

(f) Acknowledgements, if any, should appear at the end of the letter but just before the references.

(g) Proofs will not ordinarily be sent to authors, unless desired.

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